

**Before the
Federal Communications Commission, Washington, D.C. 20554**

In the Matter of	}	
	}	
Revision of Part 15 of the Commission's	}	
Rules Regarding Ultra-Wideband	}	ET Docket No. 98-153
Transmission Systems	}	

**Multispectral Solutions, Inc. Comments in
Response to Further Notice of Proposed Rule Making (ET Docket 98-153)**

Multispectral Solutions, Inc. (MSSI) is pleased to submit these comments in response to the Federal Communications Commission's Further Notice of Proposed Rule Making (FNPRM) in the above referenced docket.

IMPORTANT NOTE: On 12 February 2003, MSSI submitted a written *ex parte* request to the FCC for immediate clarification of Rule 15.35(b). The very next day, on 13 February 2003, the FCC adopted its Memorandum Opinion and Order and Further Notice of Proposed Rule Making. The FNPRM formally requested the same information that MSSI provided in its 12 February 2003 document. Thus, for completeness, this information is being resubmitted as MSSI's formal comments in response to the FNPRM. Moreover, in its Petition for Reconsideration in this proceeding, MSSI urged the Commission to find that low pulse repetition frequency ("PRF") ultra wideband ("UWB") systems uniformly have a lower interference potential than high PRF systems. A copy of MSSI's Petition for Reconsideration, filed May 21, 2003, also is being resubmitted herewith because of its relevance to the issues raised in the FNPRM.

Since the adoption of the First Report and Order on February 14, 2002 over 17 months ago, only two companies (Time Domain Corporation and Multispectral Solutions, Inc.) have had products certified under the new UWB rules. Furthermore, each of these three products is either restricted in its customer use (e.g., for sale only to the public safety sector) or in its application (e.g., indoor use only, non-vehicular use, etc.). These customer and application restrictions were imposed because the FCC was originally led to believe that UWB equipment *must* operate over §15.205 restricted bands and such compromises were deemed necessary to protect existing spectrum users.

However, MSSI and others have demonstrated that it is not only possible, but imminently practical, to design and implement UWB equipment which can operate in *non-restricted* frequency bands. For example, MSSI's *Spider650* UWB radar (FCC Identifier QCJSPDR650) operates between the frequencies of 6.020 and 6.699 GHz, or well within the non-restricted band from 5.46 to 7.25 GHz (and above the 6.0 GHz frequency limit supported by a vast number of companies and organizations which have submitted to this record).

Under the current UWB rules, *Spider650* cannot be used in many applications where it could be of considerable consumer benefit, including numerous safety-of-life uses. For example,

Spider650 cannot be used in vehicles where it can operate as a very low cost, collision avoidance sensor, blind spot detector or backup sensor. Nor can the device be used for general aviation aircraft or helicopters, where it can function as a low false alarm sensor for short range altimetry (height above ground) or wire detection radar for collision avoidance. Similarly, it cannot be installed onboard a ship or boat for precision docking, collision avoidance or security applications.

However, since *Spider650* operates in the *non-restricted* frequency spectrum, it is appropriate to consider certification under pre-existing FCC rules for unlicensed operation wherein specific applications are not limited. This is not currently possible because of an existing interpretation of §15.35(b) having to do with pulse desensitization correction.

The attached submission clearly addresses this extremely important issue, and demonstrates that the use of pulse desensitization correction for dealing with wideband waveforms has no technical basis. Rather, such an interpretation incorrectly penalizes wide bandwidth waveforms (not just UWB) which have a demonstrated ability to create less interference than similar power narrow band systems.

In conclusion, MSSSI recommends that the FCC not directly change the existing UWB rules (i.e., Subpart F). Rather, MSSSI respectfully requests that the FCC provide a definitive interpretation of §15.35(b), namely removal of the requirement for pulse desensitization correction above 1 GHz. This interpretation would remove inappropriate and unnecessary restrictions on the use of wideband waveforms operating in non-restricted spectrum. The benefits in doing so are immense. This simple change will free the fledgling UWB industry from the myriad of restrictions which are hampering the ability to commercialize the technology. This change will also allow the introduction of commercially viable UWB equipment into the marketplace in a responsible manner. With this change, unlicensed use of the spectrum for wideband devices will still need to satisfy one of two constraints – operation in restricted bands will continue to require adherence to UWB subpart F rules; whereas operation in non-restricted bands will require adherence to pre-existing Part 15 rules (particularly §15.35, §15.205 and §15.209), without the need for pulse desensitization correction.

Respectfully submitted,

/s/ Robert J. Fontana, Ph.D.
President

21 July 2003

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February 12, 2003

Marlene H. Dortch
Secretary
Federal Communications Commission
The Portals
445-12th Street, S.W.
Washington, D.C. 20554

**Re: Written Ex Parte Presentation in ET Docket No. 98-153—Request of
Multispectral Solutions, Inc. for Immediate Clarification of Rule 15.35(b)**

Dear Ms. Dortch:

Multispectral Solutions, Inc. ("MSSI"), by its attorneys, hereby respectfully requests the Commission to hold that Section 15.35(b) of the rules does not require pulse desensitization correction ("PDC") for emission measurements of Part 15 devices operating *above 1 GHz*. This request was first submitted by MSSI more than eight months ago in the context of the Ultra-Wideband ("UWB") rulemaking in ET Docket No. 98-153. In the interim, MSSI has met with senior officials in the Office of Engineering and Technology ("OET") to explain why this interpretation of Rule 15.35(b) is appropriate and correct. An immediate grant of this request would serve the public interest because it would encourage the development of UWB technologies and foster the commercial deployment of new UWB products and services.

Much of the controversy surrounding UWB technology arises from a concern that some UWB devices would place intentional emissions in certain sensitive or safety-related frequency bands that are designated as restricted bands, or in frequency bands allocated for television broadcasting.¹ To date the Commission has authorized the operation of some types of UWB products in these restricted bands, albeit under very conservative technical standards. Other uses of UWB technology, however, such as UWB products developed by MSSI, do not put intentional emissions into the restricted frequency bands. Under MSSI's proposed interpretation of Rule 15.35(b), MSSI could proceed to deploy such UWB devices without implicating the most difficult issue facing the Commission in its ongoing UWB rulemaking, *i.e.*, adopting terms and conditions under which UWB devices will be permitted to operate in the restricted bands. Adopting MSSI's proposal not only would permit MSSI to deploy UWB products commercially without risk of interference to operations in the restricted bands, but it also would encourage other manufacturers to develop UWB devices that avoid operating in the restricted bands.

¹ See Section 15.209 of the Commission's rules.

The only thing preventing these developments from occurring is an anomaly created by OET's interpretation of Rule 15.35(b) that requires a PDC factor to be applied when measuring certain emissions. The Commission itself rejected this measurement criteria for UWB-specific rules in Subpart F in its *First Report and Order* in this proceeding. Moreover, the U.S. GPS Industry Council, which has sought vigorously throughout this proceeding to protect safety-related frequency bands from harmful interference, has informed the Commission that it supports MSSSI's interpretation of the applicable rule. Importantly, the National Aeronautics and Space Administration ("NASA") also has advised the National Telecommunications and Information Administration ("NTIA") and MSSSI that it, too, supports MSSSI's proposed change to Rule 15.35(b). In addition, Randal J. Burnette, the Founder and President of Synergent Technologies, Inc., who authored Agilent Technologies' current application note on "Radar Pulse Measurements with a Spectrum Analyzer," has told the Commission that the predecessor document, Hewlett Packard ("HP") Application Note 150-2, is not applicable in this context. For these and other reasons set forth below, MSSSI urges the FCC to clarify Rule 15.35(b) immediately by holding that a pulse desensitization correction factor is not required for measuring emissions of Part 15 devices operating above 1 GHz.

Background

MSSSI is a recognized industry leader in the development of UWB systems for communications, radar and precision geo-location applications. Since its inception in 1989, MSSSI has received 65 contract awards to develop and field UWB equipment for the U.S. Government and military. As a result, MSSSI has extensive experience with regard to the myriad of technical issues surrounding UWB technology.

MSSSI desires to market low power UWB devices operating in non-restricted frequency bands above 1 GHz. A current OET interpretation of the PDC requirements, however, prevents Part 15 certification for a number of MSSSI products and services that do not operate in restricted bands and would otherwise qualify for certification under the general Part 15 rules. Specifically, OET has advised its Telecommunications Certification Bodies ("TCBs") that they must take into account a pulse desensitization correction factor under Rule 15.35(b) when considering pulsed emissions, regardless of whether the operational frequency of the Part 15 device is above or below 1 GHz. OET has pointed to HP Application Note 150-2 as a rationale for requiring PDC under Rule 15.35(b).

On June 14, 2002, MSSSI filed a Petition for Reconsideration in the UWB rulemaking urging the Commission to interpret Rule 15.35(b) as **not** requiring pulse desensitization correction for emissions above 1 GHz.² MSSSI noted that Rule 15.35(b) stipulates that measurements (both peak and average) above 1 GHz are to be performed using a minimum resolution bandwidth of 1 MHz, *yet the rule makes no mention of a need for pulse desensitization*

² Petition for Reconsideration filed by MSSSI on June 14, 2002, *In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket No. 98-153. A copy of MSSSI's Petition is provided in Attachment 1 hereto.

correction. Furthermore, MSSSI showed that if PDC is required above 1 GHz, then UWB emissions permitted under Part 15's new Subpart F rules would be significantly higher (at least 41.25 dB) than those permitted under pre-existing Part 15 limits, and that such higher emissions would occur in the restricted bands. In other words, the Commission permits UWB devices under new Subpart F to place intentional emissions in restricted bands many orders of magnitude in excess of the emission limits permitted under pre-existing Part 15 rules for the non-restricted bands. This result reflects an obvious contradiction between OET's interpretation that Rule 15.35(b) requires PDC and the Commission's new Subpart F regulations.

On July 29, 2002, MSSSI filed Reply Comments in the UWB rulemaking to address the applicability of HP Application Note 150-2 to this issue.³ Specifically, MSSSI noted that pulse desensitization correction was used by Hewlett Packard and radar engineers to determine the true, full bandwidth peak power from measurements made with a modern spectrum analyzer, which allows an engineer to determine total peak power from measurements of the power spectral density (*i.e.*, Watts per Hertz bandwidth) in a given resolution bandwidth. From an interference perspective, however, full bandwidth peak power is irrelevant, as it is only the energy (power) received within the victim receiver's bandwidth that causes interference. MSSSI noted that this, of course, is precisely what a spectrum analyzer measures without the need for PDC.

The Record in this Proceeding Supports MSSSI's Request for Relief

Interested parties have had ample opportunity to comment on MSSSI's request for the FCC to hold that Rule 15.35(b) does not require pulse desensitization above 1 GHz. MSSSI's Petition for Reconsideration was listed on a *Public Notice* that invited opposition filings on the issues raised in the MSSSI Petition.⁴ While numerous parties reflecting diverse business and technical perspectives have participated fully throughout the course of these UWB proceedings, no party has opposed MSSSI's request for a ruling that Rule 15.35(b) does not require PDC above 1 GHz. To the contrary, key industry participants have supported MSSSI's request in recent filings with the Commission.

For example, on December 20, 2002, the U.S. GPS Industry Council ("Council") informed the FCC that it "supports strongly" MSSSI's requested rule change and urged the Commission to adopt these minor changes in this proceeding.⁵ The Council notes that rather

³ Petition for Reconsideration (Reply Comments) filed by MSSSI on July 29, 2002, *In the Matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, ET Docket 98-153*. A copy of MSSSI's Reply Comments is provided in Attachment 2 hereto.

⁴ See FCC *Public Notice*, Report No. 2560, released July 3, 2002; see also *Federal Register*, Vol. 67, No. 136, p. 46668, published July 16, 2002.

⁵ See letter of Raul R. Rodriguez, counsel to the U.S. GPS Industry Counsel, to Ms. Marlene H. Dortch, Secretary of the FCC, dated December 20, 2002, a copy of which is provided in Attachment 3.

than encouraging UWB operation to occur in previously restricted bands of operation, MSSSI's recommendation would provide incentive for UWB equipment manufacturers to build devices that operate in non-restricted bands in the upper microwave frequencies (e.g., 5.46-7.25 GHz, 8.50-9.0 GHz, 9.5-10.6 GHz). The Council also observed that MSSSI's proposal would pave the way for the responsible advancement of new digital wireless technologies without damaging the noise floor due to unlicensed density of operations in spectrum that has been protected for decades because of the need by national security and public safety services for operational predictability.

The Council's support for MSSSI's recommendation is significant, especially considering the vigilance of Global Positioning System ("GPS") interests in this proceeding to protect the GPS bands at 1176.45, 1227.60 and 1575.42 MHz from harmful interference from UWB devices. As the Commission has observed, GPS will be relied upon increasingly for air navigation and safety, and it is a cornerstone for improving the efficiency of the air traffic system.⁶ The Commission also noted that GPS may be used by commercial mobile radio E-911 services to enable police and fire departments to locate individuals quickly in times of emergency.⁷ Moreover, the use of GPS is expanding for use by businesses and consumers for all types of applications, such as navigation by automobiles, boats and other vehicles, surveying, hiking and geological measurements.⁸ In this context, the strong support of the U.S. GPS Industry Council for MSSSI's proposal is forceful corroboration that deleting the PDC requirement from Rule 15.35(b) would not lead to interference into sensitive and safety-related services.

Further support for MSSSI's petition has come from NASA.⁹ Specifically, NASA commented that "[w]hile a seemingly simple request, MSSSI's Petition has far reaching consequences for the responsible introduction of UWB devices into the commercial marketplace. In particular, removal of the requirement for PDC above 1 GHz would encourage the use of existing, *non-restricted* spectrum by new digital technologies (such as UWB), thereby further protecting the viability of GPS and other safety-of-flight/safety-of-life services." As with the support of the U.S. GPS Industry Council, NASA's support for the MSSSI proposal is strong testimony by a key spectrum user group that eliminating PDC from Rule 15.35(b) emission measurements above 1 GHz will not have adverse interference consequences for licensed spectrum users.

⁶ See *First Report and Order* in ET Docket 98-153, 17 FCC Rcd 7435 (2002), at 7450 (hereinafter "*First Report and Order*")

⁷ *Id.*

⁸ *Id.* at 7450-51.

⁹ See letter of David P. Struba, NASA IRAC Representative, to Dr. Robert J. Fontana, President of Multispectral Solutions, Inc., dated February 5, 2003, a copy of which is provided in Attachment 4. This letter was also sent by NASA on January 31, 2002, to Mr. Karl Nebbia, Chairman of the Interdepartment Radio Advisory Committee, National Telecommunications and Information Administration.

Preco Electronics, Inc., which for 50 years has offered a wide variety of safety products targeted at the commercial vehicle industry, also strongly supports MSSSI's position on pulse desensitization correction.¹⁰ Specifically, Preco agrees with MSSSI that the full bandwidth theoretical peak power calculation has no relevance in defining interference potential, and that the original intent of Rule 15.35 very adequately accounts for emissions above 1 GHz by requiring measurement using a peak detector with a bandwidth of 1 MHz or greater. As noted in Preco's comments, this measurement provides a normalized peak power spectral density that is unbiased, has a long history of proven adequacy, and provides an accurate indication of interference potential that is easily understood.

As noted above, HP Application Note 150-2 cannot be used as a rationale for requiring PDC under Rule 15.35(b) for emissions above 1 GHz. Indeed, Randal J. Burnette, the Founder and President of Synergent Technologies, who is the author of Agilent Technologies' current application on "Radar Pulse Measurements with a Spectrum Analyzer," and who is working with Agilent to update the entire 150 series of application notes, recently advised the Commission that PDC is not required to determine the potential interference effects of a wide pulse waveform.¹¹ Rather, as noted by MSSSI, pulse power density (i.e., watts per Hz, dBm/MHz, etc.), whether determined on an average or peak basis, is the relevant parameter for this purpose.

In view of this support, and considering that no party has objected to MSSSI's request after opportunity to be heard, the Commission should grant MSSSI's request without further delay and remove the PDC requirement from Rule 15.35(b) for emissions above 1 GHz.

Immediate Grant of MSSSI's Request Would Serve the Public Interest

Grant of MSSSI's request would serve the public interest by encouraging the development of UWB technologies and fostering the deployment of new commercial UWB products and services. Indeed, the Commission has stated that UWB technology holds promise for a vast array of new or improved devices that could have enormous benefits for public safety, consumers and businesses.¹² The Commission also has observed that UWB technologies will create new business opportunities for manufacturers, distributors and vendors that will enhance competition and the economy.¹³ Furthermore, UWB technology will enable increased use of

¹⁰ See Reply Comments of Preco Electronics, Inc. in ET Docket No. 98-153, January 3, 2003, a copy of which are provided at Attachment 5.

¹¹ See letter of Randal J. Burnette, Founder and President of Synergent Technologies, to Marlene H. Dortch, Secretary of the FCC, dated January 12, 2003, a copy of which is provided as Attachment 6.

¹² See *Notice of Proposed Rulemaking* in ET Docket No. 98-153, FCC 00-163, June 14 2000, at para. 8 (hereinafter *NPRM*); see also *First Report and Order*, 17 FCC Rcd at 7443.

¹³ See *NPRM* at para. 8; see also *First Report and Order*, 17 FCC Rcd at 7443.

scarce spectrum resources by sharing frequencies with other services without causing interference, thereby resulting in the more efficient use of the spectrum.¹⁴

Grant of the MSSSI request would further each of these policy objectives. For example, eliminating a PDC requirement from Rule 15.35(b) for emissions above 1 GHz would facilitate the sale and commercial deployment by MSSSI of a number of new UWB devices that will benefit both consumer and public safety interests. To name just a few examples:

- UWB tagging systems for location of high valued assets (both equipment and personnel) in hospitals, factories, etc.;
- UWB collision and obstacle avoidance sensors for vehicular and general aviation applications (enabling aeronautical DO-160 compliant UWB devices);
- UWB devices for Homeland Security applications – intrusion and through-wall sensors, RFID tags, personnel location devices, etc.

The commercial availability of these and other UWB products and services from MSSSI and other companies will result in significant public interest benefits.

Moreover, as noted in the comments of the U.S. GPS Industry Council and the National Aeronautics and Space Administration, grant of MSSSI's request will provide incentive for UWB equipment manufacturers to develop devices that operate in non-restricted bands in the upper frequency ranges, such as 5.46-7.2 GHz, 8.50-9.0 GHz and 9.5-10.6 GHz. The Commission's Subpart F standards assume that a UWB device will require emissions in the restricted frequency bands in order to perform. Subpart F thus includes a number of application-specific restrictions to protect against possible interference to sensitive operations in these bands. However, these restrictions are not necessary if a UWB product can comply with the Commission's general Part 15 rules, including the avoidance of any intentional emissions in the restricted bands. Thus, if MSSSI's requested relief were granted, manufacturers would have a strong reason to design UWB products that avoid operations in the restricted bands.

The Commission has stated that it should adopt reasonable regulations that will foster the development of UWB technologies while continuing to protect existing radio services from interference.¹⁵ Here, there is no risk of interference to other radio services by virtue of granting MSSSI's request. Simply put, pulse desensitization (*without* correction) is precisely the mechanism which makes UWB signals difficult to intercept and which minimizes interference from UWB to other services. Furthermore, by enabling UWB operation in *non-restricted* frequency bands, the protection of spectrum users heretofore provided by limits imposed on restricted band operations under part 15.205 will continue.

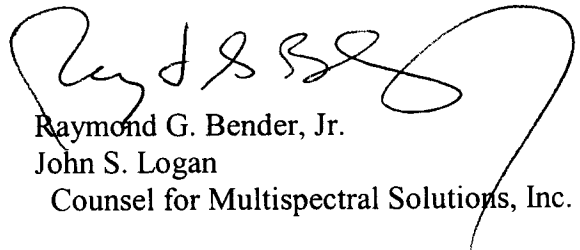
¹⁴ See *First Report and Order*, 17 FCC Rcd at 7443. The FCC noted in the *NPRM* that it is important for the Commission to find ways to encourage the development and deployment of technologies that may allow for more efficient use of the spectrum. See *NPRM* at para. 8.

¹⁵ See *NPRM* at para. 8.

Finally, MSSSI urges the Commission to grant this relief as soon as possible. This proposal is simple and straightforward and, as both the U.S. GPS Industry Council and NASA note, involves a change that is "minor" in nature. Because the issue is discrete and uncomplicated, MSSSI urges the Commission to resolve it immediately rather than relegate it to further rulemaking proceedings that will be time-consuming because of the need to resolve far more complex UWB issues. In short, the MSSSI request is ripe for decision and the Commission therefore should proceed at once to clarify that PDC is not required under Rule 15.35(b) for emissions above 1 GHz.

In accordance with Section 1.1206 of the FCC' rules, an original and one copy of this letter are being submitted to the Secretary of the Commission.

Respectfully submitted,



Raymond G. Bender, Jr.
John S. Logan
Counsel for Multispectral Solutions, Inc.

cc: Mr. Ed Thomas
Mr. Julius Knapp
Dr. Michael Marcus
Ira Keltz, Esquire
Mr. John Reed

Attachment 1



MULTISPECTRAL SOLUTIONS, INC.

A Tradition of Excellence in Innovation

14 June 2002

DOCKET FILE COPY ORIGINAL

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
Office of the Secretary
445 12th Street, SW
Washington, DC 20554

Dear Ms. Dortch:

Attached please find two (2) copies of a Petition for Reconsideration of ET Docket 98-153 (FCC 02-48) concerning Ultra-Wideband Transmission Systems.

An electronic copy of this petition has also been submitted to the FCC's Electronic Comment Filing System.

Thank you very much.

Sincerely,

Robert J. Fontana, Ph.D.
President

Enclosures

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Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	}	
	}	
Revision of Part 15 of the Commission's	}	
Rules Regarding Ultra-Wideband	}	ET Docket No. 98-153
Transmission Systems	}	

PETITION FOR RECONSIDERATION

Filed by: Multispectral Solutions, Inc.
 20300 Century Boulevard
 Germantown, MD 20874
 (301) 528-1745

Date: 14 June 2002

I. BACKGROUND OF THE COMMENTER

Multispectral Solutions, Inc. (MSSI) ("Petitioner") is a recognized industry leader in the development of ultra wideband (UWB) systems for communications, radar and precision geolocation applications. Since its inception in 1989, MSSI has received 65 contract awards to develop and field UWB equipment for the U.S. Government and military. As a consequence, MSSI has extensive experience with the technical issues relating to UWB technology, and is uniquely qualified to provide expert opinion in this Docket.

II. ELIGIBILITY TO PETITION FOR RECONSIDERATION

The Petitioner filed timely comments and reply comments in this docket. Each of the changes requested in this PETITION is eligible for FCC reconsideration under one or more of the following justifications:

- (a) The adopted rule significantly changes existing FCC policy, but this change in policy was not proposed by or was not acknowledged in the original Notice of Proposed Rule Making.
- (b) The adopted rule is in contradiction with other established FCC rules or with established and continuing FCC policy.
- (c) The adopted rule is in material error.
- (d) There are additional facts not known or not existing until after the Petitioner's last opportunity to present such matters.

III. THE NEW UWB RULES, TAKEN INTO CONTEXT WITH RECENT FCC ACTIONS, CONFLICT WITH EXISTING PARTS 15.35 AND 15.209 OF THE COMMISSION'S RULES.

In its grant of waivers (15 June 1999) to Time Domain Corporation, U.S. Radar Inc. and Zircon Corporation, the Commission stated that

“The specific rules waived are: Section 15.205(a), which specifies that only spurious emissions may be placed in certain designated restricted frequency bands of operation; and, Sections 15.31 and 15.35 which require the application of a pulse desensitization correction factor when performing certain measurements below 1000 MHz.”¹ (Bold emphasis added.)

¹ FCC Public Notice, “The Office of Engineering and Technology Grants Waivers for UltraWide Band Technologies,” FCC 99-1340, 8 July 1999.

Note that §15.35(b) of the Commission's Rules states that

“On any frequency of [sic] frequencies above 1000 MHz, the radiated limits shown are based upon the use of measurement instrumentation employing an average detector function. When average radiated emission measurements are specified in the regulations, including emission measurements below 1000 MHz, there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules, e.g. see Section 15.255. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. Measurement of AC power line conducted emissions are performed using a CISPR quasi-peak detector, even for devices for which average radiated emission measurements are specified.”

Thus, the FCC reconfirms in its grant of waivers for UWB technologies that pulse desensitization correction (PDC) is required for emissions *below* 1 GHz; while §15.35(b) further stipulates that measurements (both peak and average) *above* 1 GHz are performed using a minimum resolution bandwidth of 1 MHz with *no mention of a need for pulse desensitization correction*.

Historically, in its Notice of Proposed Rule Making (FCC 87-300) relating to Part 15 devices which first established §15.35, the Commission wrote:

“[T]he use of a CISPR quasi-peak detector, as described in CISPR Publication 16, gives a better indication of the interference potential of a signal since it provides a closer

*representation of the power density of the radiated signal, accounting for the peak emissions.”*² (**Bold** emphasis added.)

Thus, the FCC also admits that it is the “*power-density of the radiated signal*”, or Watts/Hz, that is a “*better indication of the interference potential*”. Furthermore, in the subsequent First Report and Order (FCC 89-103), the Commission states:

*“[W]e have deleted the requirement that ‘suitable adjustment’ must be made to the measured results for emissions that are wider than the bandwidth of the measuring instrument. Such adjustments are not needed with the use of CISPR quasi-peak measurements as these measurements **determine the permitted emission level per unit bandwidth** anywhere within the entire range of frequencies emitted by the Part 15 device. Thus, the **measurement procedure is effective in controlling interference potential without a corresponding need to integrate the measured field strength to a high level simply because the Part 15 device is broadbanded.**”*³ (**Bold** emphasis added.)

Again, the Commission confirms that it is unnecessary to integrate the measured field strength, or equivalently, to limit full bandwidth peak power, to protect systems which may be affected by broadband Part 15 devices.

² FCC 87-300, “Notice of Proposed Rule Making – Revision of Part 15 of the rules regarding the operation of radio frequency devices without an individual license,” released October 2, 1987.

³ FCC 89-103, “First Report and Order – Revision of Part 15 of the Rules regarding the operation of radio frequency devices without an individual license,” released April 18, 1989.

Recently, MSSSI submitted a UWB device for FCC certification. NTIA tested an early version of this device⁴ – Device “A” of the referenced report. With a 1 MHz resolution bandwidth, the MSSSI UWB device exhibited an average power which was 35 dB *below* Part 15 limits of 500 $\mu\text{V/m}$ at 3 meters⁵, and exhibited a worst case peak power at 5700 MHz of 75 dB $\mu\text{V/m}$ (5623 $\mu\text{V/m}$) at 1 meter; or, equivalently, 1874 $\mu\text{V/m}$ at 3 meter range⁶. Thus, with a 20 dB peak-to-average ratio limitation as specified in §15.35(b), the UWB device exhibited a peak power which was 8.5 dB *below* Part 15 limits of 5000 $\mu\text{V/m}$ at 3 meters. The device had a pulse repetition frequency (PRF) of 10 Kpps (10,000 pulses per second).

As the MSSSI UWB device had a portion of the main spectral lobe falling within the §15.205(a) restricted band 5.35 to 5.46 GHz; the device was redesigned to operate at a slightly higher operational frequency to stay within the 5.46 to 7.25 GHz non-restricted region. (Note: The original device “A” was also tested by an FCC-certified testing laboratory and MSSSI was told that the unit passed §15.209 general emission limits, but failed the §15.205(a) criterion for intentional emissions in restricted bands)

Upon frequency redesign, the UWB device was again tested by the same laboratory, and MSSSI was notified that the unit was now fully compliant with §15.35 §15.205(a) and §15.209. The

⁴ Kissick, W.A., editor, “The Temporal and Spectral Characteristics of Ultrawideband Signals,” U.S. Department of Commerce, NTIA Report 01-383, January 2001.

⁵ Kissick, W.A., Figure D.A.23, page D-A-14.

⁶ Kissick, W.A., Figure 8.3, page 8-5.

new UWB device has an operational frequency range of 6.1 to 6.6 GHz and an operational PRF of approximately 30 Hz. The unit was tested by the certification laboratory at its worst case PRF of 100 Kpps, which represented a test mode for the device. Final documentation processing for the device for Part 15 certification was scheduled for May 15, 2002.

On 15 May 2002, MSSSI was notified by the certification laboratory that the FCC had held a teleconference the day before (on 14 May 2002) with all of its TCBs (Telecommunications Certification Bodies). The FCC notified the TCBs that it was now necessary to take into account pulse desensitization when considering pulsed emissions, regardless of the operational frequency of the device. At that point, MSSSI contacted Mr. John Reed from the FCC's Office of Engineering and Technology (OET) for clarification. Mr. Reed indicated that §15.35 was to be interpreted as limiting the *total peak power* for a Part 15 device to -21.25 dBm (*numerically* 20 dB above the -41.25 dBm/MHz average limit), and that this limit was a "full bandwidth" limit. That is, -21.25 dBm represented the total peak power as measured in the full bandwidth of the pulse, not in the "greater than 1 MHz" bandwidth as specified in §15.35(b). Pulse desensitization correction was now necessary for *all* frequencies, irrespective of whether the emission fell above or below 1 GHz.

However, in its First Report and Order (FCC 02-48) for Ultra Wideband technology, the FCC clearly states:

*“...we believe that our proposal to permit a peak emission within a 50 MHz RBW of only -21.25 dBm EIRP is too conservative. We believe that the peak emission level of 0 dBm/50 MHz, equivalent to 58 mV/m at 3 meters, requested by TDC would not result in harmful interference problems to communications systems. This level translates to a peak EIRP of -24.44 dBm/3 MHz or 3.6 μW/3 MHz, or to a peak field strength of 3.46 mV/m at [sic] measured at 3 meters with a 3 MHz RBW. **This peak level is 16.8 dB higher than the average level determined with a 1 MHz RBW and is 3.2 dB lower than the peak limit permitted under the current Part 15 rules.**”⁷ (Bold emphasis added.)*

Thus, according to the UWB First Report and Order, 0 dBm/50 MHz peak EIRP is 3.2 dB lower than the peak limit permitted under current Part 15. Indeed, 0 dBm/50 MHz results in a peak field strength of 3,460 μV/m which is 3.2 dB below the 5,000 μV/m peak limit imposed by §15.35 *if measured in a 3 MHz bandwidth*. Note that §15.35 only specifies that the bandwidths exceed 1 MHz for measurements.

Now, if §15.35 limits are indeed -21.25 dBm for *total full bandwidth power*, consider a 500 MHz bandwidth UWB signal, the minimum bandwidth required above 3.1 GHz under the new rules. According to the new rules, the peak signal power can be 0 dBm/50 MHz, for a *total full bandwidth power of +20 dBm*. (Note that peak power increases as 20 log bandwidth.) This peak power, according to the FCC’s new “interpretation” of §15.35, is **41.25 dB higher than Part 15 “limits” (-21.25 dBm full bandwidth power)**. This is an obvious contradiction.

⁷ FCC 02-48, First Report and Order – Revision of Part 15 of the Commission’s Rules Regarding Ultra-Wideband Transmission Systems,” adopted February 14, 2002; released April 22, 2002.

Figure 1 graphically illustrates the problem with FCC's 15 May 2002 re-interpretation of §15.35.

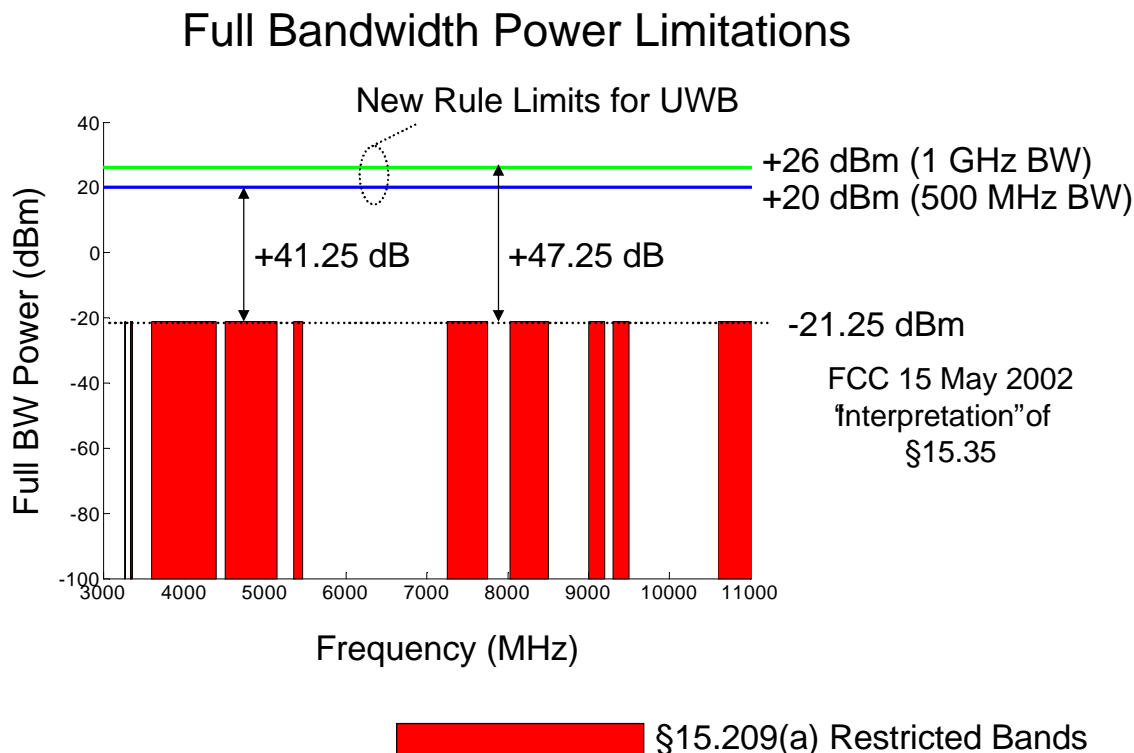


Figure 1. Inconsistencies between FCC re-interpretation of §15.35 and UWB R&O.

Thus, if pulse desensitization correction is required above 1 GHz, then UWB emissions under the new Subpart F would be a *minimum* of 41.25 dB or 13,335 TIMES HIGHER THAN EXISTING PART 15 LIMITS WITH THESE HIGHER EMISSIONS NOW OCCURRING IN PREVIOUSLY RESTRICTED BANDS. There is not a single comment relating to this issue in the entire UWB proceeding; nor do the FCC's briefing charts on the UWB R&O reflect this interpretation. Concerned spectrum users will indeed be shocked to learn what the actual approved UWB power levels represent. Thus, it must be concluded that the FCC's new "interpretation" of the existing law (i.e., §15.35 and §15.209) is inconsistent with the present UWB First Report and Order.

Proposed Changes

The FCC must not arbitrarily and capriciously re-interpret existing Part 15 regulations, specifically §15.35 and §15.209:

If the FCC now believes that pulse desensitization correction is required *above* 1 GHz, and that -21.25 dBm was the previous Part 15 limit on *full bandwidth peak power*; then the peak power limit of 0 dBm/50 MHz as specified in the UWB First Report and Order is a minimum of 41.25 dB *higher* than that specified in Part 15. To be consistent with Part 15 and the vast record in this proceeding, the FCC must limit the *full bandwidth peak power* of UWB emissions to -21.25 dBm, for there is no discussion in this docket of permitting emission levels (whether peak or average) higher than existing Part 15.

If the FCC wishes to retain the limitation of 0 dBm/50 MHz for UWB emissions as stated in the UWB First Report and Order; then it is imperative that the FCC correctly interpret §15.35(b) as not requiring pulse desensitization correction above 1 GHz. To clarify this issue, the FCC should modify §15.35(b) in the current First R&O to explicitly state this fact. Note that this interpretation would still maintain a limit on peak emissions (i.e., no greater than 20 dB above the maximum average emission), but would measure such emissions appropriately as *peak spectral density* as originally intended in the vast record of documents and testimony related to §15.35.

IV. THE FCC UNNECESSARILY RESTRICTS THE FREQUENCY OF OPERATION FOR LOW PRF UWB APPLICATIONS (E.G., VEHICULAR RADAR)

Given peak power constraints as indicated in §15.509(f), §15.511(f), §15.513(f), §15.515(f),

§15.517(f) and §15.521(g); the lower the pulse repetition frequency (PRF), the lower the average power and, hence, the lower the probability for potential interference to other services. Indeed, as pointed out in numerous submissions into the record from NTIA, Stanford/DOT and others; low PRF systems (particularly those with PRFs less than 100 Kpps^{8,9}), were particularly benign to extremely sensitive GPS receivers and had effects considerably less deleterious than even additive white Gaussian noise. Furthermore, as pointed out numerous times to the Commission in this Docket, low PRF UWB systems offer advantages – e.g., low probability of interference, multipath mitigation, high efficiency for extended battery life, etc.– which are virtually unmatched by any other currently available form of wireless technology.¹⁰

Thus, it makes little sense for the FCC to restrict the operation of low PRF devices, e.g. vehicular radars, in the same region of the spectra (e.g., 3.1 to 10.6 GHz) that it is considering for the use of high-speed communications devices which have been shown to have a significantly higher

⁸ Anderson, D.S., E.F. Drocella, S.K. Jones and M.A. Settle, "Assessment of Compatibility between Ultrawideband (UWB) Systems and Global Positioning Systems (GPS) Receivers", NTIA Special Publication 0445, Feb. 2001.

⁹ J. Randy Hoffman, Michael G. Cotton, Robert J. Achatz, Richard N. Statz and Roger A. Dalke, "Measurements to Determine Potential Interference to GPS Receivers from Ultrawideband Transmission Systems", NTIA 01-384, Feb. 2001.

¹⁰ Gunderson, S.J. et al., "Naval Total Asset Visibility (NTAV) Precision Asset Location (PAL)," Technical Report TR-2201-AMP, Naval Facilities Engineering Service Center, Port Hueneme, CA, May 2002. This 200+ page report documents the performance of low PRF UWB systems vs. conventional spread spectrum technologies for asset location applications in severe multipath conditions, and contains the results of extensive Government testing of UWB technology in real world environments.

potential for interference. MSSI, NTIA and others have recommended to the Commission that limits be placed on the PRF within certain regions of the spectrum. Indeed, the use of UWB devices – irrespective of their functionality – having PRFs less than 100 Kpps has been demonstrated by the NTIA to pose significantly less of an interference problem than do communications devices, and should be permitted within the 3.1 to 10.6 GHz region.

Furthermore, in its 13 February 2002 submission to this docket, the NTIA states:

*“Imaging systems, vehicular radar systems, and hand-held systems will be permitted to operate outdoors, provided the emissions in the GPS bands are below the Part 15 general emission limit.”*¹¹

Thus, the FCC’s restriction of UWB vehicular radars to the frequency band 22 – 29 GHz is arbitrary, capricious and without basis in the facts presented to the Commission under the UWB NPRM.

Proposed Changes

Based upon established facts in this proceeding, the FCC should permit the general use of low PRF (<100 kpps) devices, including UWB vehicular radars, within the 3.1 to 10.6 GHz region of the spectrum.

¹¹ “NTIA Summary Analysis of UWB Interference to GPS and Non-GPS Systems,” U.S. Dept. of Commerce, National Telecommunications and Information Administration, *ex parte* submission to Docket ET 98-153, 13 February 2002.

V. THE RULES PERMIT THE USE OF OTHER THAN “PULSED EMISSIONS WHERE THE BANDWIDTH IS DIRECTLY RELATED TO THE NARROW PULSE WIDTH”¹², YET THE RECORD CONTAINS NO DISCUSSION OF THE RATIONALE FOR PERMITTING SUCH EMISSIONS

In the UWB NPRM, the FCC stated:

“We also request comment on whether we should define UWB devices as limited to devices that solely use pulsed emissions where the bandwidth is directly related to the narrow pulse width. We recognize that other types of modulation, such as linear sweep FM, could be employed to produce UWB equipment. However, we do not believe that we have sufficient information to propose limits and measurement procedures for such systems. Until more experience is gained, we believe that our initial rule making proposals should reflect a conservative approach. In addition, we request comment on whether extremely high speed data systems that comply with the UWB bandwidth requirements only because of the high data rate employed, as opposed to meeting the definition solely from the narrow pulse width, should be permitted.”¹

No test results were submitted into the record for other than pulsed emissions. Indeed, no data was provided into the record for any systems with greater than an approximate 40 MHz pulse repetition frequency, nor for pulse widths greater than approximately 5 nanoseconds. Hence, all test data fell within the regime for systems in which the bandwidth was completely determined by the narrow pulse width and *not* the data modulation.

¹² FCC 00-163, “Notice of Proposed Rule Making – Revision of Part 15 of the Commission’s Rules Regarding Ultra-Wideband Transmission Systems,” 11 May 2000.

Thus, the FCC's definition of "Ultra-wideband (UWB) Transmitter" [§15.503(d)], in which a UWB radiator is defined solely by means of its fractional or instantaneous bandwidth irrespective of the nature of the waveform, is inconsistent with the record, and runs contrary to the FCC's desire for a conservative approach as specified in its NPRM.

As a specific example, biphase modulated, high data rate systems which utilize direct sequence techniques (i.e., high-speed chipping sequences), have not been adequately tested with respect to their potential interference effects

Proposed Changes

The FCC should modify §15.503(d) to be consistent with the record in this proceeding. Specifically, the wording must exclude "*high speed data systems that comply with the UWB bandwidth requirements only because of the high data rate employed*" as no opportunity to comment on, or to test, such devices was provided in the proceeding. A recommended change to §15.503(d) is as follows:

Ultra-wideband (UWB) transmitter. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth. Explicitly excluded are devices which achieve wide instantaneous bandwidths because of the use of high data rates; i.e., in which the bandwidth is modulation dependent

VI. THE NEW RULES CONFLICT WITH SPECTRUM MASKS FURNISHED BY THE FCC ON 14 FEBRUARY 2002

In its 14 February 2002 approval of the First R&O, the FCC supplied a set of spectrum masks which indicated emission limits for various devices approved under the order. For example, the spectral mask for indoor communications systems is shown in Figure 1 below; while the mask for imaging systems is illustrated in Figure 2³.

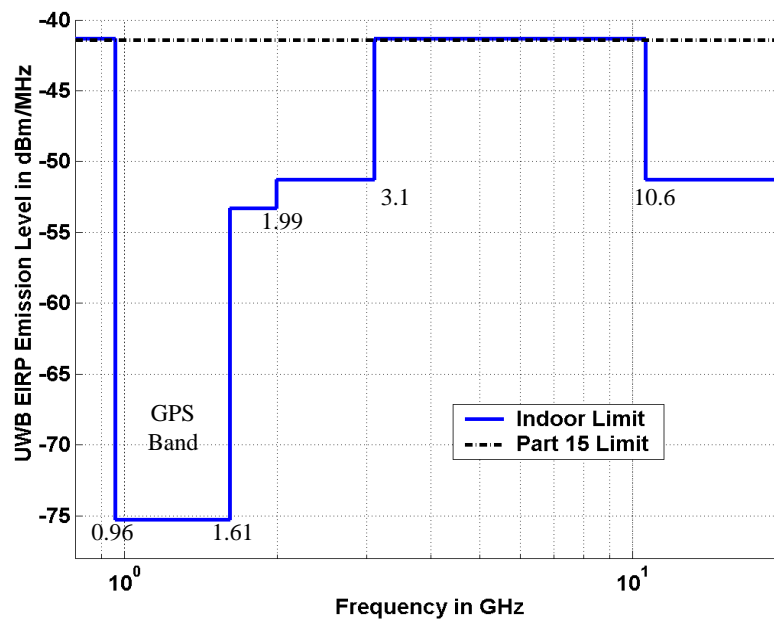


Figure 1. FCC Spectrum Mask for Indoor Communications Systems.

¹³ Thomas, E., "Walk don't run – the first step in authorizing ultra-wideband technology," Plenary Session, 2002

IEEE Conference on Ultra Wideband Systems and Technologies, Baltimore, MD, 20-23 May 2002.

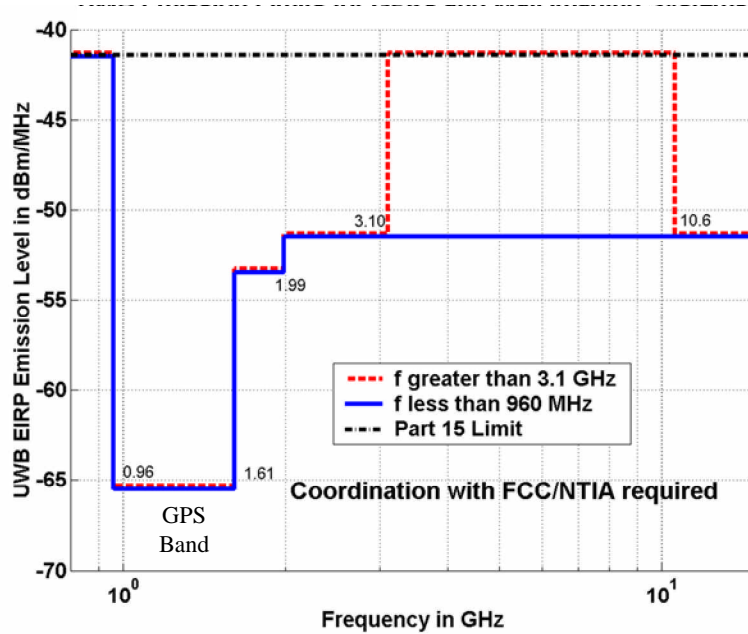


Figure 2. FCC Spectrum Mask for GPRs, Wall Imaging, & Medical Imaging Systems.

Note that, in all cases, only a single limit (500 $\mu\text{V/m}$, or -41.25 dBm/MHz) was specified below 960 MHz.

However, this is inconsistent with the R&O wherein it is stated [e.g., §15.509(d), §15.511(d), §15.513(d), §15.515(d), §15.517(c) and §15.519(c)] that

“The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209 of this chapter.”

§15.209(a) specifically states that the emissions from an intentional radiator operating below 960 MHz must not exceed the following maximum field strengths:

<u>Frequency (MHz)</u>	<u>Field Strength (μV/m)?</u>	<u>Measurement Distance (m)</u>
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3

Thus, for example, in the frequency range 216 to 960 MHz, §15.209(a) specifies that the emissions must be 8.0 dB *lower* than as specified in the Subpart F FCC spectrum masks. In the 30 to 88 MHz portion of the spectrum, emissions must be 14.0 dB *lower*.

Proposed Changes

While it may have been the FCC's intent to increase §15.209(a) general emission limits below 960 MHz, nothing in the record has been provided to support this increase. Thus, the FCC should clarify that the charts provided by OET do not correctly reflect the wording of Subpart F. To prevent confusion, it is recommended that the FCC explicitly include the above table in Subpart F.

Attachment 2

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	}	
	}	
Revision of Part 15 of the Commission's	}	
Rules Regarding Ultra-Wideband	}	ET Docket No. 98-153
Transmission Systems	}	

PETITION FOR RECONSIDERATION (REPLY COMMENTS)

Filed by: Multispectral Solutions, Inc.
20300 Century Boulevard
Germantown, MD 20874
(301) 528-1745

Date: 29 July 2002

In recent technical discussions^{1,2}, the Office of Engineering and Technology pointed out that the rationale and measurement techniques for pulse desensitization correction (PDC) are contained in Hewlett Packard (HP) Application Note 150-2.³ This was further indicated as the basis for applying PDC to pulse waveforms under 47 CFR Part 15.35 of the Commission's rules.

HP Application Note 150-2 does indeed address the rationale for applying PDC to correctly measure total (i.e., full bandwidth) peak power using a spectrum analyzer. However, the rationale for applying PDC has nothing whatsoever to do with determining

¹ Telephone conversation between Mr. John Reed, FCC OET and Dr. Edward Richley, MSSSI, 15 May 2002.

² *Ex parte* Meeting with Mr. Ed Thomas, et al. (FCC OET) and Dr. Robert Fontana and Mr. Robert Mulloy, 18 July 2002.

³ "Spectrum Analysis ... Pulsed RF", Hewlett Packard Spectrum Analyzer Series, Application Note 1502, November 1971.

the potential for interference from pulsed devices. Rather, as pointed out in the HP application note regarding the topic of pulse desensitization,

“Pulsing a CW carrier results in its power being distributed over a number of spectral components (carrier and sidebands). Each of these spectral components then contains only a fraction of the total power.”⁴

Indeed, the application note acknowledges that “pulsing a CW carrier”, or equivalently generating a bandpass pulse response, results in “only a fraction of the total power” being present in the measurement (or, equivalently, victim receiver) bandwidth.

Hence, the only point the HP application note is making is that full bandwidth peak power, a measurement required by radar system designers to determine potential system performance, is not always equal to the power as measured in any given spectral slice. However, it is precisely this “fraction of the total power” that causes interference. That is, it is the *power spectral density* (Watts per Hz or MHz) that determines the potential to interfere.⁵

Thus, HP Application Note 150-2, as well as the record in 47 CFR Part 15.35⁵, strongly support the fact that PDC (except as expressly stated for frequencies below 1 GHz) is not required for measurements made above 1 GHz. As pointed out in MSSSI’s recent Petition for Reconsideration⁵, the acceptance of this fact (namely, that PDC is not required above 1 GHz) permits the rationalization that the new limits for Ultra Wideband (Part 15.501)

⁴ HP Application Note 150-2, pages 6-7.

⁵ Petition for Reconsideration, ET Docket 98-153, Multispectral Solutions, Inc., 14 June 2002 (amended 18 June 2002).

are indeed more conservative than previously existing Part 15, rather than many orders of magnitude larger.

To further clarify the problem, consider the following three signal examples:

- (a) A pulsed signal having a 2 GHz instantaneous bandwidth with a +32 dBm full bandwidth peak power operating in the 3.1 to 10.6 GHz band;
- (b) A CW carrier having a -41.25 dBm peak power operating in the 15.205 non-restricted bands; and,
- (c) A 4 nanosecond pulse having a 0 dBm full bandwidth peak power operating in the 15.205 non-restricted bands.

Example (a) is legal under the new UWB rules (§15.501). It has a peak power spectral density of 0 dBm/50 MHz or -34 dBm/MHz. (Assume the pulse rate is low enough to satisfy the average power requirement.)

Example (b) is legal under previous Part 15 rules with a peak and average power spectral density of -41.25 dBm/MHz.

Example (c) is illegal under both §15.501 and previous Part 15 rules (as recently interpreted by OET). Its measured peak power spectral density, however, is only -44.4 dBm/MHz.

Thus, while illegal, Example (c) has the lowest power spectral density! Interestingly, if one now ADDS the signal of Example (a) to the signal of Example (c), it suddenly

becomes legal! In other words, simply adding 2 GHz of broadband noise to a less interfering, but illegal signal, makes the new signal legal.

Conclusion

In summary, pulse desensitization correction (PDC) was used by Hewlett Packard (and radar) engineers to determine the true, full bandwidth peak power from measurements made with a modern spectrum analyzer (HP Application Note 150-2). It allows the engineer to determine total peak power from measurements of the power spectral density (i.e., Watts per Hertz bandwidth) in a given resolution bandwidth. From an interference perspective, however, full bandwidth peak power is irrelevant, as it is only the energy (power) received within the victim receiver's bandwidth that causes interference. This, of course, is precisely what the spectrum analyzer measures without the need for PDC.

In its Petition for Reconsideration, and in a subsequent *ex parte* presentation, MSSI pointed out the serious inconsistency between requiring the application of PDC above 1 GHz and the new UWB regulations. An additional example of the problems which this interpretation causes was provided above. Specifically, adding many hundreds of MHz worth of noise to a signal which happens to fail Part 15 on account of pulse desensitization correction, now makes the signal legal and it can *now even operate in previously restricted bands!*

The solution to this dilemma is obvious and consistent with the vast record in this proceeding and in the deliberations leading up to the introduction of §15.35. Thus, the FCC should remove the requirement for pulse desensitization correction for

measurements made above 1 GHz. Note that, in doing so, the peak power density will still remain limited to 20 dB above the maximum average power density.

Attachment 3



LEVENTHAL SENTER & LERMAN PLLC

December 20, 2002

RAUL R. RODRIGUEZ
(202) 416-6760

E-MAIL
RRODRIGUEZ@LSL-LAW.COM

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Written Ex Parte Presentation in ET Docket 98-153

Dear Ms. Dortch:

The U.S. GPS Industry Council ("Council"), through undersigned counsel, and pursuant to Section 1.1206 of the Commission's Rules, 47 C.F.R. Sec. 1.1206, provides the following comments in support of the Petition for Reconsideration submitted by Multispectral Solutions, Inc. ("MSSI") in the above referenced docket.

In its Petition, MSSI requests that the Commission add appropriate language to Section 15.35 of its Rules removing the requirement for pulse desensitization correction ("PDC") above 1 GHz. MSSI argues in its Petition that removing the requirement for PDC above 1 GHz would encourage the use of existing *non-restricted* spectrum by new digital technologies (such as UWB), thereby further protecting the viability of GPS and other safety-of-flight/safety-of-life services that operate in the lower frequency bands.

Furthermore, rather than encouraging UWB operation to occur in previously restricted (*see* 47 C.F.R. § 15.205) bands of operation (as noted in the present UWB Report and Order), MSSI's recommendation would provide incentive for UWB equipment manufacturers to build devices that operate in non-restricted bands in the upper microwave frequencies (e.g., 5.46 – 7.25 GHz, 8.50 – 9.0 GHz, 9.5 – 10.6 GHz). The proposal would also pave the way for the responsible advancement of new digital wireless technologies without damaging the noise floor due to unlicensed density of operations in spectrum that has been protected for decades because critical national security and public safety services require operational predictability – lives depend on it.



For the reasons set out in MSSSI's Petition, the Council supports strongly MSSSI's requested change in the Commission's rules and urges the Commission to adopt these minor changes in this proceeding. We file an original and one copy of this letter with electronic copies to the parties listed below.

Sincerely,

Raul R. Rodriguez
Counsel to The U.S. GPS Industry Council

RRR:rjc

cc by e-mail: Dr. Robert Fontana
Dr. Edward Thomas
Dr. Julius Knapp
Mr. John Reed
Ms. Karen Rackley

Attachment 4

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001



Reply to the Attn of: MT

February 5, 2003

Dr. Robert J. Fontana
President
Multispectral Solutions, Inc.
20300 Century Boulevard
Germantown, MD 20874

Reference: FCC ET Docket 98-153 Ultrawideband Transmission Systems

Dear Dr. Fontana:

The National Aeronautics and Space Administration (NASA) has reviewed the Petition for Reconsideration ("Petition") submitted by Multispectral Solutions, Inc. (MSSI) in the above referenced proceeding (see Enclosure 1). Specifically, your company has requested that the FCC add appropriate language to §15.35 of the Commission's Rules removing the requirement for pulse desensitization correction (PDC) above 1 GHz.

While a seemingly simple request, MSSI's Petition has far reaching consequences for the responsible introduction of UWB devices into the commercial marketplace. In particular, removal of the requirement for PDC above 1 GHz would encourage the use of existing, *non-restricted* spectrum by new digital technologies (such as UWB), thereby further protecting the viability of GPS and other safety-of-flight/safety-of-life services.

Furthermore, rather than encouraging UWB operation in previously restricted (§15.205) bands as noted in the present UWB Report and Order (R&O), MSSI's recommendation would provide incentive for UWB equipment manufacturers to utilize non-restricted bands in the upper microwave frequency bands (e.g., 5.46 – 7.25 GHz, 8.50 – 9.0 GHz, 9.5 – 10.6 GHz). MSSI's proposal would also pave the way for the advancement of new digital wireless technologies without encroaching upon spectrum that is important to national security, public safety and science.

The MSSI Petition also addresses the dilemma associated with proposed relaxation of UWB emission constraints in the 960 to 1610 MHz region. From test data available to date, we believe that such a relaxation is inconsistent with the goal of protecting safety-of-life/flight systems. MSSI's Petition provides a workable compromise by allowing UWB technology to advance without necessitating a change to the current UWB R&O. Enclosure 2 contains our recommendations for changes to §15.35.

If you have any questions concerning this matter please contact Mr. James E. Hollansworth at (216) 433-3458 or e-mail jhollansworth@grc.nasa.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "David Struba". The signature is fluid and cursive, with the first name "David" and last name "Struba" clearly distinguishable.

David P. Struba
NASA IRAC Representative
Office of Space Flight

Enclosures

Cc:

NASA HQ/M/R.Spearing

/M/D. Struba

/M/J. McNeff

/M/J. Rush

/M/L. Knight

/G/S. Mirmina

NASA Glenn/6140/W. Whyte, Jr., MS 54-2

/6140/J.Hollansworth, MS 54-2

/6140/P. Lowry, MS 54-2

/6140/R. Spence, MS 54-2

/6140/Official Files

Enclosure 1

Clarification of Pulse Desensitization Correction (PDC) Factor

Rod Spence
NASA Glenn Research Center

The PDC factor is used in the measurement of pulse modulated sinusoidal signals in order to correct for the finite resolution bandwidth (RBW) of the spectrum analyzer when estimating the peak envelope power of the signal. The meaning is best understood by example. Figure 1 shows a uniform pulse modulated sinusoidal signal with the following parameters:

pulse width $\tau = 20$ nanoseconds (ns)
pulse amplitude $A = 1$ volt
carrier frequency $f_o = 1$ GHz
interpulse period $T_p = 200$ ns
pulse repetition frequency = PRF = $1/T_p = 5$ MHz
duty cycle = DC = $\tau/T_p = 0.1$ (10%)

The peak envelope power of this signal is simply $P_{\text{peak}} = A^2/2 = 0.5$ Watts and the total average power is $P_{\text{peak}} \times \text{DC} = 0.05$ W.

Figure 1a. Uniform Rectangular Pulse Modulated Sinusoidal Signal

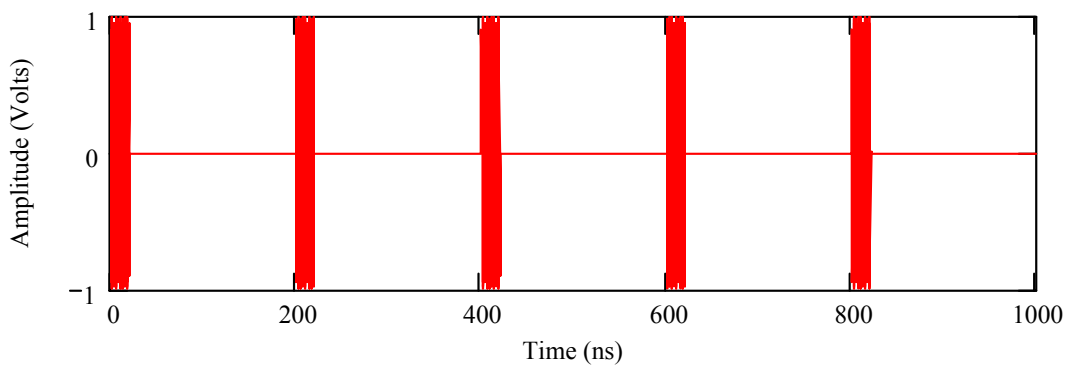
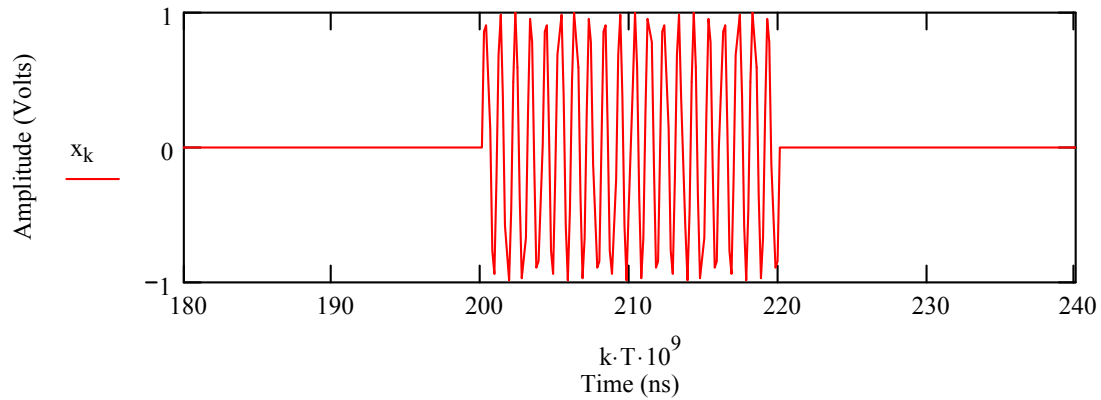


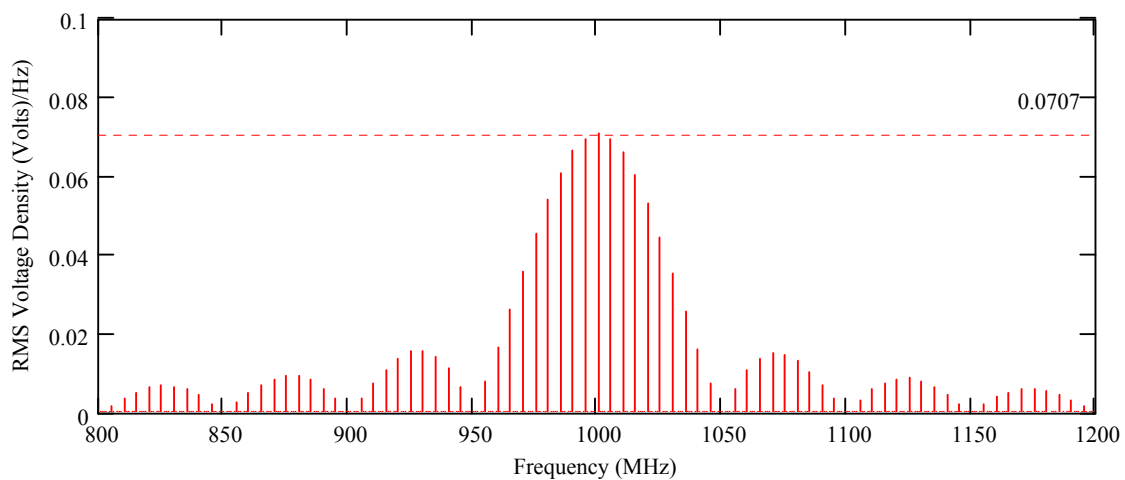
Figure 2a. Close-up of one of the sinusoidal pulses (20 ns pulse at 1 GHz carrier frequency)



Note that since this signal is a periodic signal ($T_p = 200$ ns) it can be represented in a Fourier series in the frequency domain. Its spectrum then consist of discrete spectral lines centered about the carrier frequency (1 GHz) as shown in Figure 2. Note that the spectral lines are spaced by the PRF (5 MHz) and that the nulls in the envelope occur at integer multiples of $1/\tau = 50$ MHz. The total average power of this signal can be found by summing over all spectral lines. The peak rms voltage level is given by:

$$V_{peak} = \frac{A}{\sqrt{2}} \cdot DC = \frac{A}{\sqrt{2}} \cdot \tau \cdot PRF \quad (1)$$

Figure 2. Line Spectrum of Pulse Modulated Sinusoidal Signal



For the values above, this yields $V_{peak} = 0.707$ V. Now suppose I'm measuring this signal with a spectrum analyzer who resolution bandwidth is $RBW = 1$ MHz. Since the spectral lines are spaced 5 MHz apart, I can only observe one spectral line at a time. This is true

so long as the RBW is less than the PRF. The question then arises, “How can I estimate the peak envelope power of the signal given that I can only observe one spectral line at a time?” We see that since the peak envelope power is $A^2/2$ and the peak rms voltage we can observe on a spectral line is given by (1), we can compute the peak power from:

$$P_{peak} = V_{peak}^2 \cdot (\tau \cdot PRF)^{-2} = A^2 / 2 \quad (2)$$

where the factor $(\tau \cdot PRF)^{-2}$ is the appropriate correction factor when the RBW is less than the PRF.

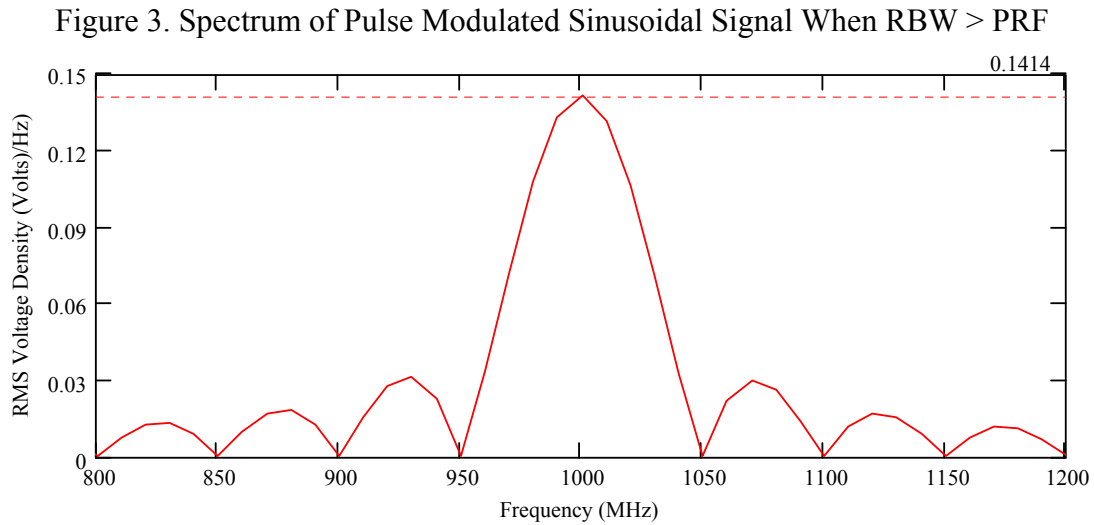
When the RBW is greater than the PRF, the individual spectral lines can no longer be observed and the spectrum is approximated by the continuous envelope shown in Figure 3. The peak rms voltage level is now given by:

$$V_{peak} = \frac{A}{\sqrt{2}} \cdot \tau \cdot RBW \quad (3)$$

Thus, under this condition, we estimate the peak envelope power from:

$$P_{peak} = V_{peak}^2 \cdot (\tau \cdot RBW)^{-2} = A^2 / 2 \quad (4)$$

where the factor $(\tau \cdot RBW)^{-2}$ is now the appropriate correction factor.



Because UWB signals do not use a CW carrier and also typically use non-rectangular pulses much shorter than those of a pulsed sinusoid, their spectrum looks much different than that shown in Figure 2. Apart from this, when looking at interference potential, it doesn't make sense to apply a PDC factor to estimate total radiated peak power (or total average power) across the entire UWB signal bandwidth since interference will be determined by the fraction of total power and portion of the power spectrum that falls in the victim receiver passband (which typically will be orders of magnitude smaller than the UWB bandwidth). Hence, there is no need to use a PDC factor on measurements of UWB signals in assessing potential UWB interference.

Enclosure 2

Recommended Change to Sec 15.35

Sec. 15.35 Measurement detector functions and bandwidths.

(b) On any frequency of [sic] frequencies above 1000 MHz, the radiated limits shown are based upon the use of measurement instrumentation employing an average detector function. When average radiated emission measurements are specified in the regulations, including emission measurements below 1000 MHz, there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules in this part, e.g., see Sec. 15.255. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. **Pulse desensitization correction should not be applied to measurements made above 1000 MHz.** Measurement of AC power line conducted emissions are performed using a CISPR quasi-peak detector, even for devices for which average radiated emission measurements are specified.

Attachment 5

**Before the
Federal Communications Commission
Washington, D.C. 20554**

In the Matter of:

Revision of Part 15 of the Commission's
Rules Regarding Ultra-Wideband
Transmission Systems

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ET Docket No. 98-153

Reply Comments of Preco Electronics, Inc.

Filed by: Preco Electronics, Inc.
 415 N. Maple Grove
 Boise, ID 83704
 (208) 323-1000

Date: January 3, 2003

Preco Electronics, Inc. respectfully submits the following reply comments in support of the "Petition For Reconsideration" submitted by Multispectral Solutions, Inc (MSSI) and received into the ECFS on June 18, 2002, as well as MSSI's "Petition For Reconsideration (Reply Comments)" received into the ECFS on July 29, 2002.

For over 50 years Preco Electronics has offered a wide variety of safety products targeted towards the commercial vehicle industry. One of Preco's newer products is a line of low-powered, short-range, object-detection radar systems capable of detecting both stationary and moving objects. These radars are simple pulsed carrier, and as a result Preco has had ample experience with Part 15 compliance testing in regards to pulsed emissions.

Pulse Desensitization Correction

The FCC's shifting interpretation of §15.35, so clearly described in MSSI's discussion of pulse desensitization correction (PDC), is particularly relevant to Preco's radar products and has had a profound effect on the ability of Preco to both demonstrate compliance and to retain the capability of building a usefully functional device. Not only has the FCC recently decided to require application of full-bandwidth

PDC calculations at the fundamental emission (well above 1 GHz), but now also at the band edges (i.e., §15.245, §15.249, etc.), and at all harmonics of the fundamental emission. Full bandwidth PDC at band edges and harmonics constrains pulse spectral emission operation to be well below the otherwise clearly stated Part 15 peak and average power limits and results in costly unnecessary filtering and performance reduction via unnecessary power reduction in the fundamental lobe.

The changes in the FCC's interpretation of §15.35 have progressed as the FCC has decided rely more and more upon the theoretical concepts developed in the well known 1971 Hewlett Packard Application Note 150-2 (see MSSI's Reply Comments for footnote reference and related comments). At first glance, this may seem like a good thing since the application note does an excellent job of describing how to accurately make pulse spectral measurements using a spectrum analyzer. This is obviously crucial to accurately evaluating pulsed device emissions. Unfortunately, the FCC carried it too far by adopting the full bandwidth peak power concepts described in the application note to be used as the method of "measuring" the pulse peak power emission levels (this cannot actually be directly measured with any standard spectrum analyzer for most pulsed operation above 1GHz, only calculated). The FCC then declares that this calculated value for theoretical peak power is the emission level which must meet the peak power limits stated in Part 15 – at the fundamental, at the band edges, and at all harmonics.

MSSI beautifully and succinctly summarized why blanket PDC above 1 GHz is unreasonable with the following text found in their "Petition for Reconsideration (Reply Comments)" :

"From an interference perspective, however, full bandwidth peak power is irrelevant, as it is only the energy (power) received within the victim receiver's bandwidth that causes interference."

It is the victim receiver's bandwidth that defines the interference potential. Put in other words, it is the emission power spectral density that needs to be measured and controlled to rationally protect against unintentional interference. MSSI clearly demonstrates that §15.35 was already doing this prior to the recent requirement for PDC above 1 GHz.

From HP Application Note 150-2, we know that a victim receiver bandwidth must be about equal to or greater than $\frac{1}{2}$ of the fundamental main lobe bandwidth in order to "see" the pulse peak power (a transient lasting the length of the pulse and repeating at the pulse repetition frequency). Otherwise, the

victim receiver will receive only a portion of the pulse spectral lines. The portion of pulse spectrum received is obviously proportional to the victim receiver bandwidth. This is why an ordinary spectrum analyzer cannot directly measure a pulse's peak transient power for many devices utilizing pulsed carrier operation above 1 GHz. This is why HP Application Note 150-2 was written and targeted towards radar designers to help them understand how to use a spectrum analyzer to characterize their radar pulses. A radar pulse must be in the nanoseconds time domain to provide reasonable range resolution. A 100 nanosecond pulse covers approximately 100 feet in space and has a main lobe bandwidth of 20 MHz. Most ordinary spectrum analyzers top out at about 3 MHz, and most radar pulses are considerably shorter than 100 nanoseconds.

Ordinarily, a receiver's bandwidth is made as small as is practically possible in order to both exclude undesired signals and to reduce the thermal noise floor, which is of course directly proportional to the receiver's bandwidth. A very sensitive receiver will by necessity have a very narrow bandwidth, and will be capable of receiving only one or a very small number of potentially interfering pulse spectral components. The limits set forth in Part 15 already adequately protect these sensitive receivers by measuring peak power spectral density in a minimum 1 MHz bandwidth. These receivers cannot ever experience even a fraction of the full bandwidth transient pulse peak power. The more wideband the pulsed emission spectrum, the lower the power of the few individual spectral components which might be received in a sensitive victim receiver.

Preco Electronics welcomes the FCC's direction to use HP Application Note 150-2 as a basis for making accurate spectral measurements of the pulse spectral components. These components are CW in time as long as the pulse is active and are therefore equal in peak and average value individually. However, Preco **strongly** agrees with MSSl that the full bandwidth theoretical peak power calculation has no relevancy, and that the original intent of §15.35 very adequately accounts for emissions above 1 GHz by requiring measurement using a peak detector with a bandwidth of 1 MHz or greater. This measurements provide a normalized peak power spectral density that is unbiased, has a long history of proven adequacy, and provides an accurate indication of interference potential that is easily understood.

Vehicular Radar Restriction

Preco Electronics also very strongly agrees with MSSl's position and comments in regards to the arbitrary restriction of mobile UWB devices in the 3.1 GHz to 10.6 GHz band. In their Petition for Reconsideration, MSSl makes the following statement:

"Thus it makes little sense for the FCC to restrict operation of low PRF devices, e.g. vehicular radars, in the same region of the spectra (e.g., 3.1 to 10.6 GHz) that it is considering for the use of high-speed communications devices which have been shown to have a significantly higher potential for interference."

As long as the FCC resolves the conflict between the allowed UWB emission levels and the standard Part 15 emission levels by removing the requirement for PDC, and the requirements for reduced emission levels below 3.1 GHz are met, then there is no potential for a higher interference probability in a mobile UWB device than in any other allowed mobile Part 15 device.

This ruling is needlessly restricting innovation by requiring mobile UWB devices to operate in a region of spectrum where component costs are much higher and technical complications further increase cost and development time.

Respectfully submitted,

Brian Bandhauer

Senior RF Engineer
Preco Electronics, Inc.

Attachment 6



5301 Buckeystown Pike
Suite 306
Frederick, MD 21704

12 January 2003

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Written Ex Parte Presentation in ET Docket 98-153

Dear Ms. Dortch:

I am providing the following comments in support of the Petition for Reconsideration submitted by Multispectral Solutions, Inc. ("MSSI") in the above referenced docket.

I am the author of Agilent Technologies' application note entitled "Radar Pulse Measurements with a Spectrum Analyzer". This document is referenced in **Agilent Measurement Solutions - Issue 1, Volume 3**¹ to assist Agilent customers in the proper use of a spectrum analyzer to measure wideband pulse parameters. Please note that Agilent now refers its customers to this document to better understand the phenomenon of pulse desensitization. The predecessor document, HP Application Note 150-2 "Spectrum Analysis of Pulsed RF", is no longer in print but is currently scheduled for revision. I am working with Agilent to update the entire 150 series of application notes.

Also, I was the co-author of three one-day seminars presented by Agilent: 'Radar Measurement Basics', 'Advanced Radar Measurements', and 'Digital Communication Measurements'. Each of the seminars has been delivered at over 35 cities worldwide. I have personally delivered each of the seminars twenty times to over 1000 engineers.

As an expert in the field of spectrum analysis and wideband measurements with over 25 years of experience, 20 years with HP/Agilent in the development of test equipment and procedures for wideband signals, I believe that I am eminently qualified to comment on the correct use of pulse desensitization correction (PDC).

Specifically, I agree with the argument made by Multispectral Solutions, Inc. (MSSI) in its Petition for Reconsideration that PDC is *not* required to determine the potential interference effects of a wideband pulse waveform. Rather, pulse power *density* (i.e.,

¹ http://www.tmintl.agilent.com/npl/tandm_news.shtml

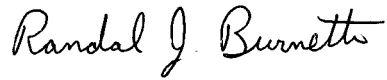
Ms. Marlene H. Dortch

12 January 2003

Page 2

Watts per Hz, dBm/MHz, etc.), whether determined on an average or peak basis, is the relevant parameter of importance.

Respectfully submitted,

A handwritten signature in black ink, reading "Randal J. Burnette". The signature is written in a cursive style with a large, stylized 'R' and a long, sweeping underline.

Randal J. Burnette
Founder and President
Synergent Technologies, Inc.
5301 Buckeystown Pike, Suite #306
Frederick, MD 21704
USA

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the matter of)	
)	
Revision of Part 15 of the Commission's Rules)	ET Docket No. 98-153
Regarding Ultra-Wideband Transmission)	
Systems)	

To: **The Commission**

**PETITION FOR RECONSIDERATION OF
MULTISPECTRAL SOLUTIONS, INC.**

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Counsel to Multispectral Solutions, Inc.

Dated: May 21, 2003

TABLE OF CONTENTS

I.	Introduction.....	2
II.	Discussion.....	4
III.	Grant of This Petition Would Serve the Public Interest.....	10
IV.	Conclusion.....	11
Appendix A: FCC Peak and Average Constraints Favor Low PRF Systems.		

SUMMARY

Multispectral Solutions, Inc. (“MSSI”) submits this Petition for Reconsideration in ET Docket 98-153 to urge the Commission to find that low pulse repetition frequency (“PRF”) Ultra-Wideband (“UWB”) systems have less potential to cause interference than UWB devices operating at a high PRF. The Commission rejected this proposition in the *Memorandum Opinion and Order* (“MO&O”) in this proceeding based on its reading of certain technical data furnished by the National Telecommunications and Information Administration (“NTIA”). MSSI submits, however, that the Commission misinterpreted relevant NTIA technical results which, when properly analyzed, fully support a finding that low PRF UWB systems uniformly have a lower interference potential than high PRF systems. MSSI urges the Commission to adopt this conclusion and, given the lack of interference from low PRF UWB devices, to permit any type of UWB device employing a low PRF to operate in the 3.1-10.6 GHz band.

Reconsideration of the *MO&O* based on the information contained in this Petition would serve the public interest. First, the Commission and courts repeatedly have noted the importance of basing FCC decisions on an accurate and complete record. Reexamining the results of NTIA’s technical data and viewing them accurately and completely, as explained herein, can only lead to a better and more informed decision by the Commission. Second, UWB technology holds great promise for a vast array of new applications that will provide significant benefits for public safety, businesses and consumers. The Commission must adopt technical analyses which accurately reflect the actual interference potential of proposed UWB systems, and which do not unduly restrict the development and deployment of new UWB products and services. For reasons explained herein, any type of UWB devices employing a low PRF should be permitted to operate in the frequency range 3.1 to 10.6 GHz.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of)	
)	
Revision of Part 15 of the Commission's Rules)	ET Docket No. 98-153
Regarding Ultra-Wideband Transmission)	
Systems)	

To: **The Commission**

**PETITION FOR RECONSIDERATION OF
MULTISPECTRAL SOLUTIONS, INC.**

Multispectral Solutions, Inc. ("MSSI"), pursuant to Section 1.429 of the Commission's rules, hereby respectfully submits this Petition for Reconsideration ("Petition") of the *Memorandum Opinion and Order* in the above-captioned proceeding regarding Ultra-Wideband ("UWB") transmission systems.¹ MSSI urges the Commission to find that low pulse repetition frequency ("PRF") UWB systems have less potential to cause interference than UWB devices operating at a high PRF. The Commission rejected this proposition in the *MO&O* based on its reading of certain technical data furnished by the National Telecommunications and Information Administration ("NTIA"). MSSI respectfully submits, however, that the Commission misinterpreted relevant NTIA technical results which, when properly analyzed, fully support a finding that low PRF UWB systems uniformly have a lower interference potential than high PRF systems. MSSI urges the Commission to adopt this conclusion. Further, given the lack of

¹ Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, *Memorandum Opinion and Order and Further Notice of Proposed Rule Making*, ET Docket No. 98-153, released March 12, 2003 (hereinafter "*MO&O*").

interference from low PRF UWB devices, the Commission should permit any type of UWB device employing a low PRF to operate in the 3.1-10.6 GHz band.

I. INTRODUCTION

MSSI is a recognized industry leader with nearly 15 years of experience in the development and deployment of UWB systems that provide a variety of communications, radar and geopositioning products and services. Dr. Robert J. Fontana, MSSI's president and founder, has been actively involved in the design and development of UWB systems, with particular emphasis on low probability of detection (LPD) applications, for over 19 years. He is a frequent invitee to the U.S. Government's Low Probability of Intercept Communications Committee (LPICC) to discuss ultra wideband technology issues. MSSI has used and applied UWB technology in the development of high-speed communications networks and data links; collision and obstacle avoidance radars; precision geolocation systems for personnel location and mapping; intelligent transportation systems (tags and electronic license plates); and other state-of-the-art UWB systems. MSSI's experience includes RF designs up to 40 GHz as well as high-speed digital processing systems extending beyond 500 Mb/s.

MSSI's clientele includes a wide variety of U.S. Government agencies, military organizations and commercial entities. Since the company's inception, MSSI has received more than 70 contract awards to develop and field UWB equipment for the U.S. Government and military. Each of these contracts has resulted in the development of UWB hardware and systems, many of which have undergone extensive test and evaluation by the Government.

UWB systems have been of prime importance to the military because they are capable of performing with low probability of detection (LPD). However, LPD performance is assured only by the use of low PRF systems, where energy buildup does not occur in an intercept

receiver or, equivalently, in a victim receiver. MSSSI has been developing and deploying UWB LPD systems for 15 years for a variety of communications, radar and geopositioning applications. Hence, MSSSI has a particular expertise with respect to this feature of UWB technology.

MSSSI previously asked the Commission to permit any type of UWB device employing a low PRF, *e.g.*, a vehicular radar system, to operate in the 3.1-10.6 GHz band. MSSSI noted that given peak power constraints embodied in various Part 15 rules, the lower the PRF, the lower the average power levels and, hence, the lower the probability for potential interference to other services. MSSSI also pointed to submissions from NTIA, Stanford/DOT and others² to show that low PRF systems, particularly those with PRFs less than a few hundred kHz, were particularly benign to extremely sensitive GPS receivers and had effects considerably less deleterious than even additive white Gaussian noise.

In the *MO&O*, the Commission denied MSSSI's request to permit any type of UWB device employing a low PRF to operate in the 3.1-10.6 GHz band.³ The Commission stated that the immunity of GPS receivers to low PRF interference does not necessarily apply to other radio systems using different receiver designs and modulation types.⁴ In the *Further NPRM* portion of its decision, the Commission repeated its disagreement with MSSSI's assertion that low PRF

² Most recently, the Defense Advanced Research Projects Agency (DARPA), under the *Networking in the Extreme (NETEX)* initiative, conducted an extensive series of tests of the interference potential of wide classes of ultra wideband systems on the avionics equipment for an F/A-18. These tests also illustrated the low interference potential of low PRF UWB emissions vis-à-vis high PRF sources. DARPA Program Manager: Mr. Steve Griggs (703) 696-2312.

³ *MO&O*, *supra*, at para. 42.

⁴ *Id.*

systems have less potential to cause interference than UWB devices operating at a high PRF.⁵ In fact, the Commission stated its belief that low PRF UWB systems can have a higher potential for causing interference than that of high PRF UWB systems, and it pointed to an NTIA publication to support this conclusion.⁶

For reasons discussed below, MSSSI respectfully submits that the Commission has misinterpreted the NTIA data furnished in this proceeding. When properly evaluated, the NTIA results demonstrate that low PRF UWB systems have a lower potential to cause interference than UWB devices operating at a high PRF.⁷

II. DISCUSSION

The present Petition for Reconsideration addresses an error in the *MO&O* which may unfairly penalize UWB systems which have proven themselves to be low probability of interference. More specifically, in its *MO&O*, the FCC stated

*With regard to MSSSI's request to permit any type of UWB device employing a low PRF, e.g., a vehicle radar system, to operate in the 3.1-10.6 GHz, MSSSI does not consider that the NTIA analysis for systems other than GPS demonstrated that the interference potential from a UWB transmitter may increase when lower PRFs are employed.[note 79]*⁸

and,

MSSSI argues that low PRF systems have less potential to cause interference than UWB devices operating at a high PRF. We disagree. As demonstrated by NTIA, low PRF

⁵ *MO&O, supra*, at para. 154.

⁶ *See Id.*, including the Commission's reference to NTIA Special Publication 01-43, *Assessment of Compatibility Between Ultrawideband Devices and Selected Federal Systems*.

⁷ Although the Commission did not concur with MSSSI that low PRF systems have less potential to cause interference than high PRF equipment, it did seek further public comment on MSSSI's request. Among other things, the Commission proposed to amend the rules to permit the operation of any UWB product under the UWB standards currently designated for hand held devices as long as the PRF does not exceed 200 kHz and the equipment employs a pulsed or an impulse modulation. MSSSI plans to comment on this proposal and on the other questions raised by the Commission in the *Further NPRM* concerning this issue.

⁸ *MO&O, supra*, at para. 42

*UWB systems can have a higher potential for causing interference than that of high PRF UWB systems.*⁹

FCC cited reference [note 79] refers to the First Report and Order¹⁰:

*NTIA investigated the potential interactions of proposed UWB systems on 15 U.S. Government systems operating between the frequencies of 960 and 5650 MHz. The systems investigated included Distance Measuring Equipment (DME) interrogator airborne receiver, DME ground transponder receiver, Air Traffic Control Radio Beacon System (ATCRBS) air transponder receiver, ATCRBS ground interrogator receiver, ARSR), Search and Rescue Satellite (SARSAT) ground station land user terminal, ASR, Next Generation Weather Radar (NEXRAD), Maritime Radar, Fixed Satellite Service (FSS) earth stations, CW and Pulsed Radar Altimeters, Microwave Landing Systems (MLS), and Terminal Doppler Weather Radar (TDWR). Table 6 denotes these systems and their frequency band of operation and summarizes NTIA's conclusions of emission limits necessary to preclude interference from a UWB transmitter operating at a height of 2 or 30 meters. The maximum UWB EIRP is the maximum signal level that NTIA calculated at which a UWB transmitter could operate without causing interference to the system when the UWB is allowed unrestricted outdoor operation independent of the UWB's pulsewidth, PRF, or other modulation schemes or the nature of its intended operation (e.g. radio determination or communication). Where there was a difference due to the PRF of the UWB emission, we have included the results from the PRF that required the UWB emissions to be reduced to the lowest level. In the column for 30 meters, "Not Applicable" indicates that the particular scenario would involve a UWB transmitter on a fixed antenna tower at the same altitude as the airborne victim, which would not be likely.*¹¹

and,

*ARSR-4. This system is used by the FAA and DOD to monitor aircraft during enroute flight to distances of beyond 465 km (250 nautical miles). NTIA used a protection criterion of an interference-to-thermal noise ratio of -10 dB, i.e., $I/N = -10$ dB, while the current protection criteria in ITU-R Recommendation M.1463 is for an I/N of -6 dB for both radionavigation and radiolocation applications of radar.²⁰⁸ NTIA calculated that low PRF operations of UWB devices, even near ground level, must be limited to -60 dBm EIRP to protect the ARSR-4. We note that the emission limits being required for emissions in the GPS bands are adequate to protect ARSR-4 operations.*¹²

⁹ *MO&O, supra*, at para. 154

¹⁰ Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, *First Report and Order*, ET Docket No. 98-153, released March 22, 2002 (hereinafter "*R&O*").

¹¹ *R&O, supra*, at para. 124.

¹² *R&O, supra*, at para. 131

The NTIA investigation referred to by the FCC is NTIA Special Publication 01-43.¹³ We respectfully submit that the FCC has misinterpreted the NTIA results as shown in the following discussion.

In Section 4.3 of NTIA Special Publication 01-43, the NTIA summarizes the test results for the ARSR-4 Radar which was referenced by the FCC as an example of how “*the interference potential from a UWB transmitter may increase when lower PRFs are employed*”. These results were summarized in Tables 4-7, 4-8, 4-9 and 4-10 of Section 4.3 reproduced below.

TABLE 4-7
Non-Dithered UWB Signal into ARSR-4 Receiver (UWB Height = 2m)

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-1.6	-59.6	-18.3	5.5
.01	-1.6	-59.6	-18.3	5.5
.1	-1.6	-59.6	-18.3	5.5
1	0.0	-61.2	-19.9	6.1
10	0.0	-61.2	-19.9	6.1
100	0.0	-61.2	-19.9	6.1
500	0.0	-61.2	-19.9	6.1

TABLE 4-8
Dithered UWB Signal into ARSR-4 Receiver (UWB Height = 2m)

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-1.6	-59.6	-18.3	5.5
.01	-1.6	-59.6	-18.3	5.5
.1	-1.6	-59.6	-18.3	5.5
1	-1.6	-59.6	-18.3	5.5
10	-1.6	-59.6	-18.3	5.5
100	-1.6	-59.6	-18.3	5.5
500	-1.6	-59.6	-18.3	5.5

¹³ Brunson, L.K. et al., “Assessment of Compatibility between Ultrawideband Devices and Selected Federal Systems,” NTIA Special Publication 01-43, U.S. Department of Commerce, National Telecommunications and Information Administration, January 2001.

TABLE 4-9
Non-Dithered UWB Signal into ARSR-4 Receiver (UWB Height = 30 m)

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-1.6	-80.0	-38.7	>15
.01	-1.6	-80.0	-38.7	>15
.1	-1.6	-80.0	-38.7	>15
1	0	-81.6	-40.3	>15
10	0	-81.6	-40.3	>15
100	0	-81.6	-40.3	>15
500	0	-81.6	-40.3	>15

TABLE 4-10
Dithered UWB Signal into ARSR-4 Receiver (UWB Height = 30 m)

PRF (MHz)	BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	-1.6	-80.0	-38.7	>15
.01	-1.6	-80.0	-38.7	>15
.1	-1.6	-80.0	-38.7	>15
1	-1.6	-80.0	-38.7	>15
10	-1.6	-80.0	-38.7	>15
100	-1.6	-80.0	-38.7	>15
500	-1.6	-80.0	-38.7	>15

In NTIA Table 4-7, it is seen that, for low PRFs (below 1 MHz), the maximum permitted UWB EIRP can be 1.6 dB *higher* than for high PRFs (above 1 MHz). However, it is also extremely important to note that this is on an *average* power basis (dBm/MHz RMS).

Note that RMS and PEAK powers are related by the equation

$$P_{RMS} = P_{peak} \delta$$

where δ is the pulse duty cycle given by $\delta = \tau R$. Here, τ is the pulse duration and R is the UWB pulse repetition frequency (PRF) or rate.

$$\text{Thus, } P_{peak} = \frac{P_{RMS}}{\tau R} \text{ or } 10 \log P_{peak} = 10 \log P_{RMS} - 10 \log R - 10 \log \tau .$$

Since τ is a fixed constant for a given UWB waveform, the peak power is seen to be inversely proportional to the PRF for a given measured RMS power.

Going back to NTIA Table 4-7, and using the above relationships, the PEAK values associated with these maximum permitted EIRP numbers are as shown in the following Table:

Table 1. ARSR-4 Performance (Peak Powers)

<u>UWB PRF (MHz)</u>	<u>Max. EIRP (Non-Dithered) (dBm/MHz peak)</u>
0.001	$-59.6 - 10 \log 10^3 - 10 \log \tau = \mathbf{-89.6 - 10 \log \tau}$
0.01	$-59.6 - 10 \log 10^4 - 10 \log \tau = \mathbf{-99.6 - 10 \log \tau}$
0.1	$-59.6 - 10 \log 10^5 - 10 \log \tau = \mathbf{-109.6 - 10 \log \tau}$
1	$-61.2 - 10 \log 10^6 - 10 \log \tau = \mathbf{-121.2 - 10 \log \tau}$
10	$-61.2 - 10 \log 10^7 - 10 \log \tau = \mathbf{-131.2 - 10 \log \tau}$
100	$-61.2 - 10 \log 10^8 - 10 \log \tau = \mathbf{-141.2 - 10 \log \tau}$
500	$-61.2 - 10 \log (5 \times 10^8) - 10 \log \tau = \mathbf{-148.2 - 10 \log \tau}$

Thus, the NTIA shows that not only are low PRF UWB emissions (0.001, 0.01 and 0.1 MHz) more difficult to detect, but the PEAK power of the 1 kHz UWB emitter used in the example was actually $-89.6 - (-148.2) = 58.6$ dB, or *725,000 times higher* than the peak power of the 500 MHz PRF UWB source. In other words, despite this significantly higher peak power, the low PRF UWB emitter caused less interference.

Note that identical conclusions can be reached for NTIA Tables 4-8, 4-9 and 4-10 for the ARSR-4 radar system. These results are typical of all of the cases where the protection criteria was based on an average (RMS) interference power.

The NTIA also considered protection criteria based upon a peak interference power constraint. Typical of these examples is the SARSAT Ground Station Land User Terminal (LUT) at 1544-1545 MHz. The maximum EIRP (dBm/MHz RMS) required to meet the protection criteria with a peak interference power constraint was shown in NTIA Table 4.37b (page 4-35).

TABLE 4-37b
Non-Dithered UWB Signal into SARSAT LUT Receiver (UWB Height = 2m)

PRF (MHz)	Peak BWCF (dB)	Maximum Permitted UWB EIRP (dBm/MHz) RMS	Delta Reference Level (dB)	Distance (km) Where Permitted UWB EIRP Equals -41.3 dBm/MHz RMS
.001	35.0	-104.4	-63.1	>15
.01	25.0	-94.4	-53.1	12.0
.1	15.0	-84.4	-43.1	7.3
1	5.0	-74.4	-33.1	4.2
10	0.0	-69.4	-28.1	3.1
100	0.0	-69.4	-28.1	3.1
500	0.0	-69.4	-28.1	3.1

For this example, the NTIA also computed the distance (km) where the permitted UWB EIRP equals -41.3 dBm/MHz RMS (last column of Table 4-37b). At a 1 kHz PRF, the peak bandwidth correction factor (BWCF) was found to be 35.0 dB; whereas at a 1 MHz PRF the peak BWCF was found to be 5.0 dB. Thus, in this NTIA example, the 1 MHz UWB signal was required to have a 30 dB (1000 times) higher peak power than the 1 kHz UWB signal in order to achieve the same RMS EIRP. Since line-of-sight range was considered in these examples, a factor of 1000 in peak power should have resulted in a factor of $\sqrt{1000} = 31.6$ in range. Thus, since the 1 MHz UWB signal had a range of 4.2 kilometers; the 1 kHz UWB signal (for the same level of interference), should have had a range 31.6 times greater, or greater than 132 kilometers. The fact that it didn't, but rather only exceeded 15 kilometers, is indicative of the fact that the lower PRF created substantially less interference in the SARSAT LUT receiver – even on a peak power basis.

Again, the NTIA's SARSAT LUT example above is typical of all of the cases where the protection criteria was based on a peak interference power.

It is also important to note that the FCC, in specifying its peak and average constraints for Part 15 devices (and, in particular, those constraints for UWB devices under Subpart F), actually itself encourages the use of low PRF UWB emissions. Appendix A below fully illustrates this.

III. GRANT OF THIS PETITION WOULD SERVE THE PUBLIC INTEREST

MSSI respectfully submits that reconsideration of the *MO&O* based on the information contained in this Petition would serve the public interest. The Commission repeatedly has emphasized the importance of basing its decisions on an accurate and complete record.¹⁴ Indeed, the Commission has noted that the development of “an accurate and complete record can only lead to a better and informed decision by the Commission.”¹⁵ For this reason, the Commission frequently accepts further pleadings containing new information in order to have as complete and accurate record as possible.¹⁶ The courts, too, have stressed that agency decisions must be predicated on a record that is factually accurate and complete.¹⁷ Thus, the Commission should reconsider the results of NTIA Special Publication 01-43 in light of MSSI’s analysis set forth herein, and it should revise accordingly its findings regarding the relative interference potential of low and high PRF UWB systems.

Moreover, the Commission has noted repeatedly that UWB technology holds great promise for a vast array of new applications that will provide significant benefits for public safety, businesses and consumers.¹⁸ Although the Commission has proceeded cautiously in this

¹⁴ *Application of Ameritech Michigan*, 12 FCC Rcd. 3309, 3323 (1997); *Amendment of Section 73.202(b), Table of Assignments, FM Broadcast Stations*, MM Docket NO. 00-123, 16 FCC Rcd. 8868, 8869 (2000)

¹⁵ *Carriage of the Transmissions of Digital Television Broadcast Station; Amendments of Part 76 of the Commission’s Rules*, 13 FCC Rcd. 22746, 22747 (1998); *see also Implementation of the Satellite Home Viewer Improvement Act of 1999*, 15 FCC Rcd. 12588, 12589 (2000).

¹⁶ *Radio Perry, Inc.*, 11 Rcd 10564, 10564 n.2 (1996); *see also Costa de Oro Television, Inc.*, 15 FCC Rcd 12637, 12641 (2000).

¹⁷ *See generally, Bonnevill International Corp. v. Peters*, 153 F. Supp.2d 763 (E.D. Pa 2001).

¹⁸ *See e.g., Revision of Part 15 of the Commission’s Rules Regarding Ultra-Wideband Transmission Systems, First Report and Order*, ET Docket No. 98-153, 17 FCC Rcd 7435, 7436 (2002) (“*First Report and Order*”); *MO&O* at ¶ 5.

docket in order to protect existing services from harmful interference, it also has observed that it must not unnecessarily constrain the development of UWB technology.¹⁹ For this reason, it plainly serves the public interest for the Commission to adopt technical analyses which accurately reflect the actual interference potential of proposed UWB systems, and which do not unduly restrict the development and deployment of new UWB products and services. As demonstrated herein, low PRF UWB systems would not cause interference to other services, and therefore any type of UWB device employing a low PRF should be permitted to operate in the frequency range from 3.1 to 10.6 GHz.

CONCLUSION

MSSI respectfully requests that the FCC reconsider its views regarding the relative interference potential of low versus high PRF UWB systems. MSSI also urges the Commission to permit any type of UWB device employing a low PRF to operate in the 3.1-10.6 GHz bands.

Respectfully submitted,

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¹⁹ *First Report and Order*, 17 FCC Rcd at 7436.

Appendix A

FCC Peak and Average Constraints Favor Low PRF Systems

Let P_{peak} be the full bandwidth peak power of an ultra wideband (UWB) waveform, and let τ be the waveform's pulsewidth and R its average pulse repetition frequency (PRF). We first consider the case in which there are no lines in the power spectral density; i.e., the case in which the UWB signal is either dithered in time or the modulation is chosen to eliminate the spectral line components.

The average power, P_{ave} , of the waveform is given by the relationship

$$P_{\text{ave}} = P_{\text{peak}} \tau R \quad (1)$$

where the product τR is the pulse duty cycle.

Now, suppose that this signal is measured in a resolution bandwidth of B_R . The fraction of the total average power contained in this measurement bandwidth, P_{ave}^m , is given by

$$P_{\text{ave}}^m = P_{\text{ave}} \frac{B_R}{B_P} \quad (2)$$

where B_P is the instantaneous pulse bandwidth. Since $B_P \approx 1/\tau$, (2) can be rewritten as

$$P_{\text{ave}}^m = P_{\text{ave}} \tau B_R = P_{\text{peak}} \tau^2 R B_R. \quad (3)$$

Next consider the peak power as measured in the resolution bandwidth B_R . For $R < B_R$, each pulse is separate and discrete at the output of the measurement filter. Thus, by conservation of energy arguments,

$$P_{\text{peak}} \tau \left(\frac{B_R}{B_P} \right) = P_{\text{peak}}^m \tau_R \quad (4)$$

where (B_R/B_P) is the fraction of energy seen by the filter, $P_{peak}\tau$ is the full bandwidth energy in a single pulse, and $P_{peak}\tau_R$ is the single pulse energy at the output of the measurement filter.

Thus, for $R < B_R$,

$$P_{peak}^m = P_{peak}\tau^2 B_R^2 \quad (5)$$

Conversely, for $R > B_R$, the measurement filter integrates approximately $R\tau_R$ pulses during its impulse response duration τ_R . Thus, the maximum peak signal value is roughly $R\tau_R$ times larger than the measured peak for a single pulse (eq. (5)), or

$$P_{peak}^m = R\tau_R P_{peak}\tau^2 B_R^2 = P_{peak}\tau^2 R B_R \quad (6)$$

That is, at high PRFs, the measured peak and average values (in a narrower bandwidth than the UWB pulse) are approximately equal. Also note that, for $R < B_R$ (i.e., at low PRFs), the measured peak-to-average ratio at the output of the measurement filter is simply B_R/R .

In summary, the measured average and peak values are given by the relationships:

$$P_{ave}^m = P_{peak}\tau^2 R B_R$$

$$P_{peak}^m = \begin{cases} P_{peak}\tau^2 B_R^2 & \text{for } R < B_R \\ P_{peak}\tau^2 R B_R & \text{for } R > B_R \end{cases} \quad (7)$$

Now the FCC mandates (47 CFR Part 15, Subpart F) that the average emissions from a UWB waveform satisfy

$$P_{ave}^m \leq 75nW \text{ in a 1 MHz bandwidth}$$

equivalent to 500 $\mu\text{V/m}$ at 3 meters; and that the peak emission²⁰ satisfy

$$\begin{aligned} P_{peak}^m &\leq 1mW \text{ in a 50 MHz bandwidth} \\ &\equiv 400nW \text{ in a 1 MHz bandwidth.} \end{aligned}$$

Thus, for a 1 MHz measurement bandwidth ($B_R=1$ MHz),

$$P_{peak} \tau^2 R \leq 75 \times 10^{-15} \text{ Joules}$$

$$P_{peak} \tau^2 \leq 4 \times 10^{-19} \text{ Joule-sec for } R < B_R$$

$$P_{peak} \tau^2 R \leq 400 \times 10^{-15} \text{ Joules for } R > B_R.$$

(8)

Note that the third inequality is always satisfied when the first is satisfied; thus, the peak power in a high data rate system ($R > B_R$) is always limited by the FCC average constraint.

Inequality relationships (8) are shown plotted in Figure 1 below.

²⁰ From FCC 47 CFR 15.521(g), “[i]f a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be $20 \log (RBW/50)$ dBm where RBW is the resolution bandwidth in megahertz that is employed.” However, as seen from Equation (7), the actual measured peak value depends upon the PRF.

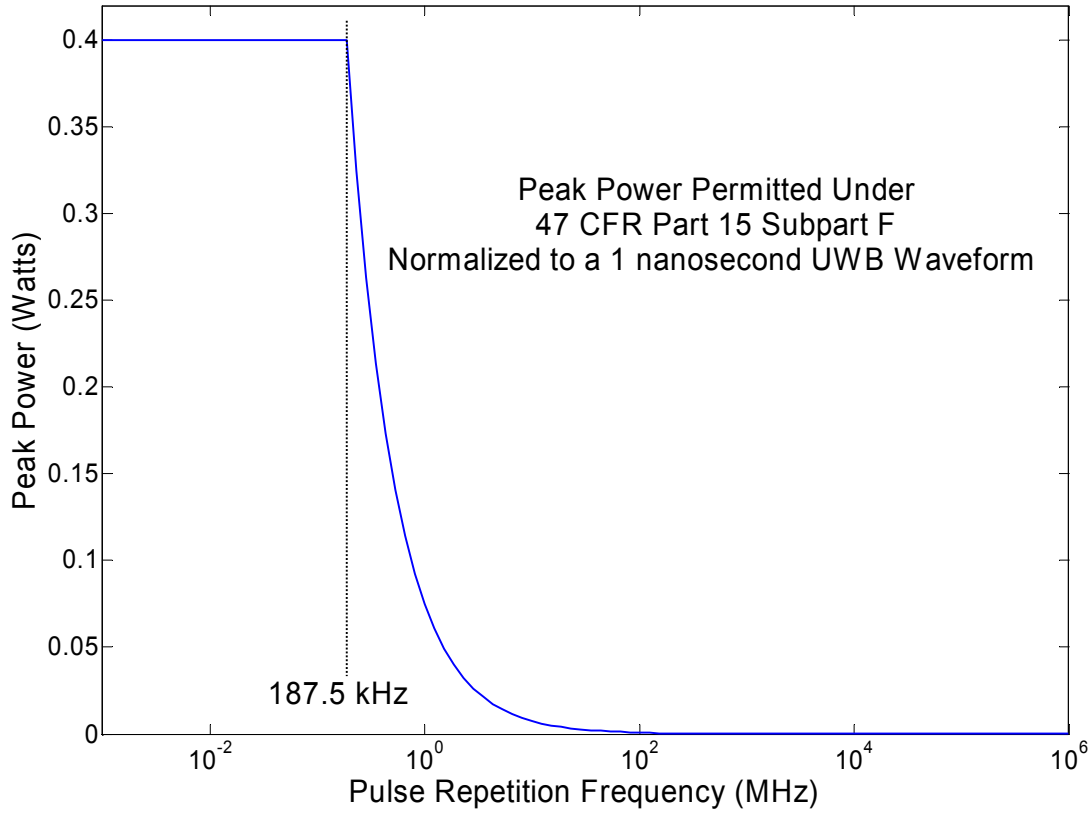


Figure 1. Inequality Constraints on $P_{\text{peak}}\tau^2$ ($\tau=1\text{ns}$)

Note that, for PRFs less than 187.5 kHz, the peak power is limited by the FCC peak constraint; whereas for higher PRFs, the peak power is limited by the FCC average constraint. For UWB emissions having spectral lines (e.g., constant PRF waveforms), it is straightforward to show that the third inequality in (8) is given by the relationship

$$P_{\text{peak}}^m = P_{\text{peak}} \tau^2 R^2 \leq 400 \times 10^{-9} \text{ Watts for } R > B_R.$$

(9)

In addition, the measured average power is equal to the measured peak power since a spectral line appears as a continuous wave (CW), constant envelope waveform. (Recall that a spectrum analyzer, as a frequency selective voltmeter with a peak detector, will measure both values the same.) Thus, in a 1 MHz resolution bandwidth,

$$P_{ave}^m = P_{peak}^m = P_{peak} \tau^2 R^2 \leq 75 \times 10^{-9} \text{ Watts for all } R > B_R. \quad (10)$$

Once again it is observed that the average constraint dominates.

Conclusion

As seen from the above equations (e.g., equation (7)), a high PRF UWB emission creates both higher average and higher peak outputs in a measurement filter or victim receiver than does a low PRF UWB emission.

In addition, it is a simple consequence of FCC Part 15 emission limits, and specifically the limits on ultra wideband emissions imposed under Subpart F, that low PRF emissions are permitted higher peak powers than high PRF emissions under the current law (cf. Figure 1).

It is a further consequence of Part 15 Subpart F emission limits, that low PRF waveforms (i.e., PRFs below 187.5 kHz) are limited in peak power irrespective of the actual PRF. In other words, the average emission power goes to zero as the PRF (and pulse duty cycle) goes to zero. Thus, under the new Subpart F, the FCC correctly protects victim receivers from the deleterious effects of high PRF waveforms. Indeed, the regulations impose substantial power penalties on the use of high PRF systems. On the other hand, these same regulations also limit the maximum permissible peak power of a low PRF UWB waveform.

Hence, the FCC by its own regulations acknowledges that low PRF UWB systems are less interfering than high PRF UWB systems.